1991 ANNUAL AIR QUALITY DATA SUMMARY

LIVINGSTON RAIL YARD

Livingston, Montana

Prepared for:

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Submittal Date:

April 2, 1992

CERTIFICATION OF DATA INTEGRITY

Bison Engineering, Inc. certifies the data contained herein is an accurate summary of air quality and meteorological conditions measured at Livingston Railyard in Livingston, Montana. Every effort was made to obtain accurate and representative data and to comply with procedures set forth in the Quality Assurance Handbook for Air Pollution Measurement Systems; Volume II, Ambient Air Specific Methods (EPA- 600/4-77-027a) and the conditions of Interim Remedial Measures Work Plan (work plan).

Project Manager: _____

Title: Senior Engineer

Date: March 24, 1992

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I. INTRODUCTION

Ambient air quality has been monitored near the Livingston Railyard since the fourth quarter of 1990. The railyard bisects the town of Livingston from the southwest to the northeast. This report focuses on the ambient air quality in the vicinity of the facility as measured during the fourth quarter of 1991.

Two PM10 monitors are operated in Livingston, one upwind and one downwind of the Livingston Railyard site. A meteorological station is also located at the downwind monitoring location. From November 1990 through July 1991, a total suspended particulate (TSP) monitor was also operated near the downwind monitor.

Envirocon, Inc. has overall responsibility for the monitoring network. Envirocon purchased and currently operates the network on a daily basis. The network was designed and is being operated in accordance with Section 14.4 of the Interim Remedial Measures Work Plan as specified by the Montana Department of Health and Environmental Sciences.

The data collected at the monitoring sites is used to determine ambient concentrations of particulate matter with a mean aerodynamic diameter of 10 microns or less (PM10). The particulate concentration is measured in accordance with the applicable requirements of federal and state guidelines (Montana Quality Assurance Manual).

A. Monitoring Locations - General

An ambient air quality network has been established near the Livingston Railyard to ascertain both the background air quality concentrations and the air quality values downwind of a number of clean-up activities. The requirements of the ambient network are contained in Section 14.4 of the Interim Remedial Measures Work Plan (work plan). The primary network consists of two distinct stations. Each station contains a PM10 air monitoring instrument. The second station (downwind site) also contains meteorological equipment.

The monitoring sites and parameters to be measured were chosen with the assistance of the Montana Department of Health and Environmental Sciences, Air Quality Bureau (AQB). The primary purpose of the upwind site is to determine the ambient air quality upwind of all remedial activities. The downwind site was chosen as a worst-case example of downwind activity. A map (Figure 1) is included with this report which

shows the location of the monitoring sites. Coordinate locations of the sites are shown in Table 1.

Table 1
Ambient Monitoring Locations

Site No.	UTM East	UTM North	Latitude North	Longitude West
1	334050	5056410	45°38'36"	113°7'46"
2	335360	5057520	45°39'13"	113°6'47"

UTM Zone = 12

The PM10 sampling schedule coincides with AQB's one-day-in-six sampling program. The samplers are owned, operated and calibrated by Envirocon, Inc. of Missoula, Montana. Bison Engineering, Inc. provides auditing, filter weighing, and data analysis. Report production for the fourth quarter of 1991 is the responsibility of Bison Engineering, Inc.

B. Monitoring Parameters

The monitoring network has been designed to collect several air pollutants. The following is a list of these parameters and the methodology used for analysis.

PM10

PM10 is a term that indicates particulate matter less than 10 microns in diameter. This parameter is commonly measured throughout the nation and represents the Montana and Environmental Protection Agency (EPA) methods for determining particulate matter in the atmosphere as it relates to ambient air quality standards. Both the upwind (Site 1) and downwind (Site 2) sites were designed to collect this information.

Method: 40 CFR Part 50, Appendix J

Total Particulates

While PM10 provides a health basis comparison for human exposure to particulates, it does not include all particulates that may be suspended in the

FIGURE 1

AMBIENT AIR MONITORING SITES

atmosphere. A high volume sampler (hi-vol) is used for this collection. The data may be compared to an earlier air quality standard for this pollutant. That standard was changed in 1987 to a PM10 methodology.

Method: Sections 1.11.1, 2.1.1, and 2.1.1.1, Montana Air Quality Bureau Quality Assurance Manual.

Meteorology

A meteorological tower was set up at the downwind site in order to assess what meteorological events may lead to increasing or decreasing ambient air pollutants. The stations collected wind speed, wind direction, temperature, and wind sigma (standard deviation of the wind direction).

Method: Anemometer cup, wind vane, thermocouple, and computer data acquisition system. "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)," Section 6, EPA, EPA-450/4-87-007.

C. Monitoring Frequency

The monitoring frequency for each parameter is provided in Table 2.

Table 2
Ambient Monitoring Frequency

PM10	One-day-in-six. 24-hour sample. Site 1 and 2.
TSP	One-day-in-six. 24-hour sample. Site 2 only.
Meteorology	Continuous sampling. Hourly data analysis. Site 2 only.

II. DATA SUMMARY

A. PM10 Particulate Data

A PM10 network has been established with samplers located at the sites noted above. PM10 monitoring began during the fourth quarter of calendar year 1990. This report includes PM10 and meteorological data for the fourth quarter as well as a summary of all PM10 and TSP data collected at the site to date.

The data for this quarter and year indicates generally low PM10 values. Mean PM10 values for the monitoring sites during the fourth quarter of 1991 were 17 $\mu g/m^3$ at Site 1 and 15 $\mu g/m^3$ at Site 2. The peak reporting value for the quarter was 30 $\mu g/m^3$ at Site 2 on October 12, 1991.

All of the measured values for the year are well below the ambient 24-hour air quality standard of 150 $\mu g/m^3$ and the annual standard of 50 $\mu g/m^3$ as shown in Table 3.

Table 3
PM10 Results versus Ambient Standards
1991

	Standard	Upwind Site	Downwind Site
Mean	50*	19	17
Peak	150**	56	34

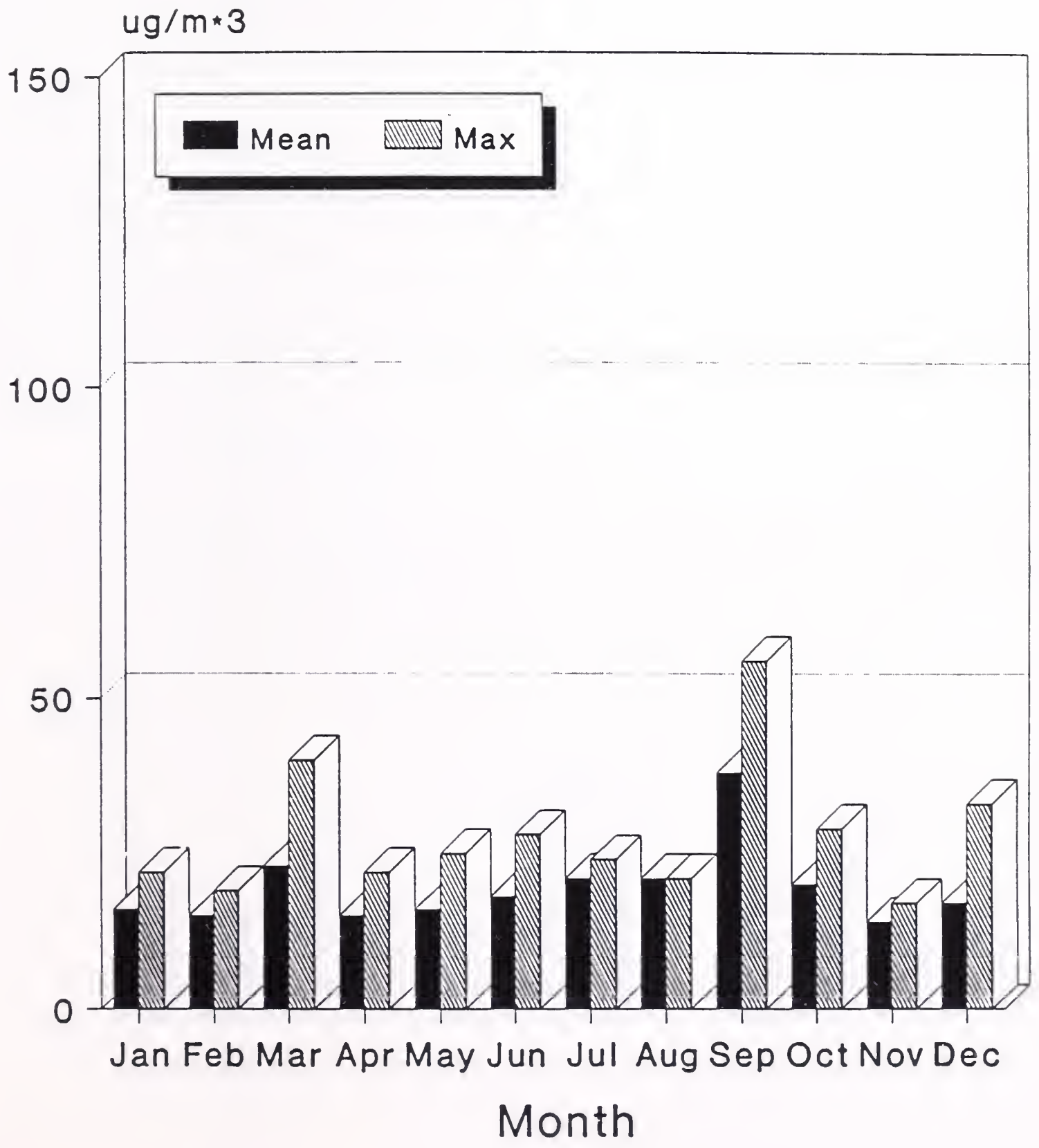
Units: $\mu g/m^3$
* Annual mean.
** Not to be exceeded more than once per year.

A complete listing of the PM10 data and various summary statistics are provided in Appendix A of this report. The statistics include monthly means, yearly mean-to-date, geometric mean and standard deviation, etc. Appendix B contains the results of calibrations and precision checks.

Figures 2 and 3 provide graphical representations of the PM10 monitoring data. The figures show monthly and seasonal trends within the particulate data distribution.

FIGURE 2

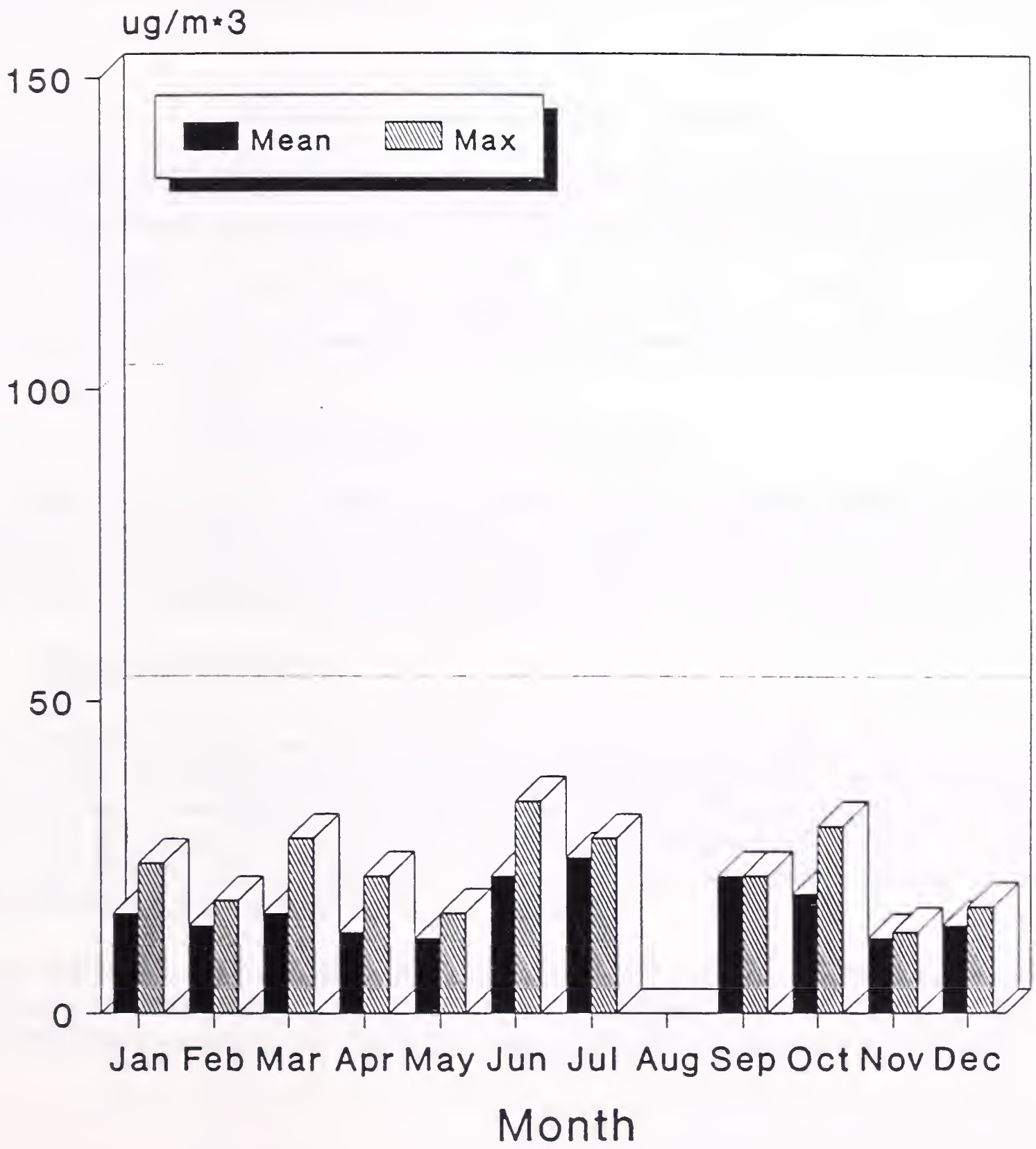
Upwind Site
PM-10 - 1991



Livingston Railyard

FIGURE 3

Downwind Site
PM-10 - 1991



Livingston Railyard

B. Total Suspended Particulate Data

The total suspended particulate network initially included the operation of one sampler at Site 2. The frequency of TSP monitor operation was the same as PM10. Operation of the TSP sampler was discontinued in July 1991. Data for 1991 includes 31 samples. The mean TSP value was 34 $\mu g/m^3$, and the peak TSP value was 67 $\mu g/m^3$. These values are compared against the old Montana ambient air quality standards in Table 4.

Table 4
TSP Results versus Old Ambient Standard

	Standard	TSP - Site 2
Mean	75*	34
Peak	260**	67

Units: $\mu g/m^3$
* Annual mean.
** Not to be exceeded more than once per year.

A complete listing of TSP data and various summary statistics are provided in Appendix A of this report. The statistics include monthly means, yearly mean-to-date, geometric mean and standard deviation, etc. Quality control information including calibration and auditing results were provided in the 1st and 2nd quarter reports.

C. Meteorological Data

The ambient monitoring network includes a meteorological station (at the downwind site, Site 2). The meteorological equipment measures wind speed, wind direction, air temperature and wind sigma. Overall data recovery for the meteorological system was good throughout 1991. During the fourth quarter, the meteorological station was off-line until October 7th. Thereafter, good data recovery was achieved at the meteorological station during the fourth quarter.

During the fourth quarter, 1991, the resultant wind direction was 225 degrees, the average wind speed was 14.4 mph, and the percentage of calm hours was 0.3%. A wind frequency summary for the fourth quarter of 1991 is provided in this report.

III. DATA ANALYSIS

A. Introduction

The primary purpose of the ambient monitoring network is to assess any impact the Livingston Railyard remediation may be having on ambient air quality. The first step in the assessment is to measure any appropriate parameters which could reasonably be expected to enter the ambient atmosphere as a result of the remediation. These parameters, defined by Section 14.4 of the work plan, include PM10 and TSP. The second step of the assessment is to compare these results with previously established ambient air quality standards, where applicable. The final step is to compare the results of the upwind and downwind monitoring site to determine potential concentrations for activities which are not influenced by the site remediation.

It is not the intent of this report to provide a complete investigation for each of these activities. It is appropriate, however, to assess some of the initial characteristics of the results to date.

B. PM10

Section II of this report provided a comparison between the collected PM10 values and the Montana and national ambient air quality standards. The results indicate values far below these levels of concern. Data to date indicates no threat of an exceedance of these standards.

It is interesting to compare the upwind and downwind monitoring results. A comparison was made between the two data sets and the results of this investigation are provided in Table 5.

Table 5
Upwind/Downwind Comparison
PM10

Sample Date	Upwind	Downwind	Difference
Nov. 10, 1990	11	10	-1
Nov. 19, 1990	20	13	-7
Nov. 25, 1990	18	18	0
Dec. 1, 1990	18	18	-6
Dec. 7, 1990	11	18	1
Dec. 14, 1990	10	18	8
Dec. 19, 1990	25	10	-15
Dec. 25, 1990	14	14	0
Dec. 31, 1990	13	16	3
Jan. 6, 1991		17	
Jan. 12, 1991	14		
Jan. 18, 1991	13	13	0
Jan. 24, 1991	15	9	-6
Jan. 30, 1991	22	24	2
Feb. 5, 1991	15	12	-3
Feb. 11, 1991	19	18	-1
Feb. 17, 1991	9	14	5
Feb. 23, 1991	15	13	-2
Mar. 1, 1991	19	8	-11
Mar. 7, 1991	12	15	3
Mar. 14, 1991	39	28	-11
Mar. 19, 1991	40	20	-20
Mar. 25, 1991	13	8	-5
Mar. 31, 1991	16	15	-1
Apr. 6, 1991	12	11	-1
Apr.12, 1991	13	6	-7
Apr. 18, 1991	10	5	-5
Apr. 24, 1991	19	19	0

Table 5 (cont.)
Upwind/Downwind Comparison
PM10

Sample Date	Upwind	Downwind	Difference
Apr. 30, 1991	22	22	0
May 6, 1991	18	16	-2
May 12, 1991	12	6	-6
May 18, 1991	13	11	-2
May 24, 1991	22	15	-7
May 30, 1991	16		
Jun. 6, 1991	19		
Jun. 11, 1991	28	34	6
Jun. 17, 1991	12	19	7
Jun. 24, 1991	21	18	-3
Jun. 30, 1991	10	18	8
Jul. 5, 1991	18	22	4
Jul. 25, 1991	28	28	4
Aug. 25, 1991	21		
Sep. 24, 1991	56		
Sep. 30, 1991	19	22	3
Oct. 6, 1991	15	14	-1
Oct. 12, 1991	26	30	4
Oct. 19, 1991	14	14	0
Oct. 24, 1991	16	14	-2
Oct. 30, 1991	29	23	-6
Nov. 6, 1991	17	13	-4

Table 5 (cont.)
Upwind/Downwind Comparison
PM10

Sample Date	Upwind	Downwind	Difference
Nov. 11, 1991	16		
Nov. 17, 1991	9	12	3
Nov. 23, 1991		10	
Nov. 29, 1991		11	
Dec. 4, 1991	9		
Dec. 10, 1991	16	14	-2
Dec. 16, 1991	33	17	-16
Dec. 22, 1991	12	10	-2
Dec. 29, 1991	13	13	0

Two statistical tests were applied to the upwind and downwind PM10 data. The tests (paired and unpaired t-test) were designed to assess whether there is enough evidence to reject the null hypothesis that the two means are the same. The results of these tests are summarized in Tables 6 and 7.

Table 6
Summary Statistics

	Upwind	Downwind	Difference
Mean	18.05	15.46	-1.92
Std. Dev.	8.54	6.14	5.90
No. of Samples	56	52	49

Table 7
Statistical Analysis

Test	Critical t	t
Paired Difference	1.96	-2.27
Unpaired Difference	1.96	-1.80

The paired difference test compares PM10 concentrations measured at the two sites during the same 24-hour period. These results show that the upwind concentrations are generally higher than the downwind concentration. Results from the unpaired difference test provide a comparison of all PM10 readings throughout the year. The unpaired t test results indicate that on a random basis, the difference between the upwind and downwind concentration is not statistically significant. Both test results indicate that the remediation activities are not increasing PM10 levels in Livingston.

C. TSP

The results of TSP sampling to date indicate values well below the previously existing ambient air quality standards. This comparison was made above. Additionally, the work plan calls for a comparison of three TSP samples in which the wind speed (during sample collection) exceeded 15 knots. This equates to a mean wind speed of 17 miles per hour. The results of TSP sampling are compared against the daily mean wind speed for the respective sampling days in Table 8.

Table 8
TSP versus Wind Speed

Sample Date	$\mu g/m^3$	MPH
Nov. 17, 1990	33	12
Nov. 25, 1990	44	26
Dec. 1, 1990	20	13
Dec. 7, 1990	34	21
Dec. 14, 1990	33	16
Dec. 19, 1990	12	13
Jan. 6, 1991	33	--
Jan. 12, 1991	43	--
Jan. 18, 1991	37	23
Jan. 24, 1991	18	11
Jan. 30, 1991	62	26
Feb. 5, 1991	30	16
Feb. 11, 1991	61	15
Feb. 17, 1991	38	11
Feb. 23, 1991	30	9
Mar. 1, 1991	20	
Mar. 7, 1991	29	17
Mar. 14, 1991	41	2
Mar. 19, 1991	43	5
Mar. 25, 1991	18	14
Mar. 31, 1991	38	14
Apr. 6, 1991	22	9
Apr.12, 1991	9	15
Apr. 18, 1991	7	9
Apr. 24, 1991	48	17

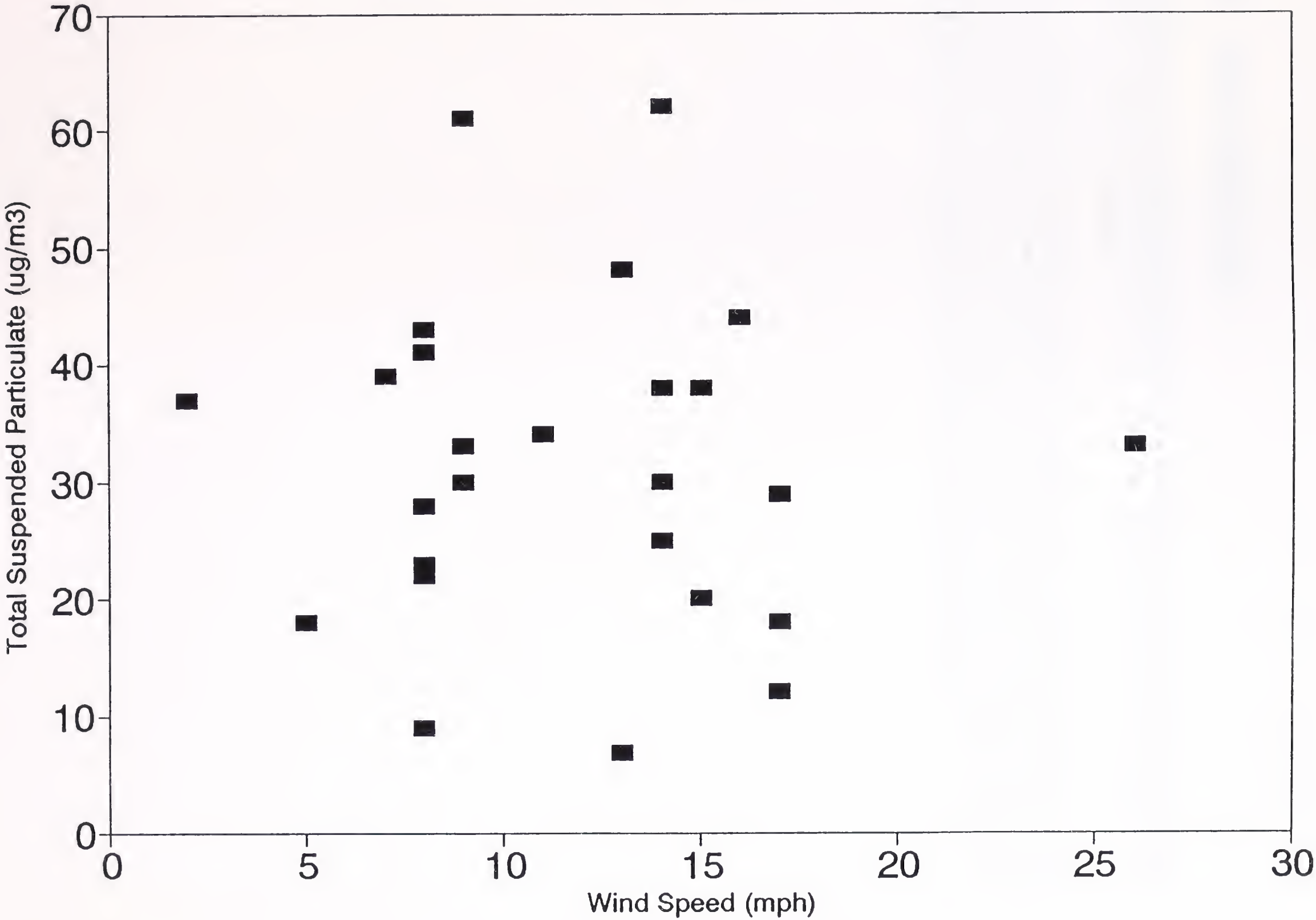
Table 8 (cont.)
TSP versus Wind Speed

Sample Date	$\mu g/m^3$	MPH
Apr. 30, 1991	39	8
May 6, 1991	25	8
May 12, 1991	23	17
May 18, 1991	23	14
May 24, 1991	27	8
May 30, 1991	29	
Jun. 6, 1991	19	8
Jun. 11, 1991	67	13
Jun. 17, 1991	41	13
Jun. 24, 1991	38	7
Jun. 30, 1991	35	14
Jul. 5, 1991	48	8

The data above has been plotted on a graph in Figure 4 below for review. Least squares regression analysis has been performed on the data. The analysis shows virtually no correlation between wind speed and TSP data. The correlation coefficient is only 0.22.

It is noteworthy that even the highest recorded reading was less than 20% of the outdated TSP ambient air quality standard.

FIGURE 4
CORRELATION OF TSP AND WIND SPEED



IV. DATA QUALITY

All sampling and analysis was conducted in accordance with EPA and Montana quality assurance procedures. The PM10 data was corrected to reference conditions (760 mm Hg - 25°C) as required.

All instruments were audited quarterly throughout the year and the results of the audits are presented in the quarterly reports. An audit was not performed during the fourth quarter due to a field inspection oversight. Regular quarterly PM10 and meteorological station audits have been resumed during the first quarter of 1992 in accordance with EPA and Montana quality assurance procedures.

V. DATA RECOVERY

Data recovery information for the entire year of 1991 is summarized below. The data recovery is a comparison of the actual number of samples obtained compared to the number of theoretical samples available. No significant problems were noted during the fourth quarter.

PM10 data recovery for the year of 1991 was 78% at the upwind site and 72% at the downwind site. Fourth quarter data recovery was 87% at both PM10 sites.

Meteorological data recovery was 86% for the year for temperature, wind speed, and wind direction. Fourth quarter data recovery was 93% for all parameters.

PM10 PARTICULATE DATA RECOVERY

Livingston, MT

Monitoring Period: **January 1 through December 31, 1991**

Variable	Total Periods	Total Measurements	Percentage Recovered
Site 1 - Upwind			
January	5	4	80%
February	4	4	100%
March	6	6	100%
Quarter	**15**	**14**	**93%**
April	5	5	100%
May	5	5	100%
June	5	5	100%
Quarter	**15**	**15**	**100%**
July	5	2	40%
August	5	1	20%
September	5	2	40%
Quarter	**15**	**5**	**33%**
October	5	5	100%
November	5	3	60%
December	5	5	100%
Quarter	**15**	**13**	**87%**
Year-to-Date	**60**	**47**	**78%**

PM10 PARTICULATE DATA RECOVERY (cont.)

Livingston, MT

Monitoring Period: January 1 through December 31, 1991

Variable	Total Periods	Total Measurements	Percentage Recovered
Site 2 - Downwind			
January	5	4	80%
February	4	4	100%
March	6	6	100%
Quarter	**15**	**14**	**93%**
April	5	5	100%
May	5	4	80%
June	5	4	80%
Quarter	**15**	**13**	**87%**
July	5	2	40%
August	5	0	0%
September	5	1	20%
Quarter	**15**	**3**	**20%**
October	5	5	100%
November	5	4	80%
December	5	4	80%
Quarter	**15**	**13**	**87%**
Year to Date	**60**	**43**	**72%**

METEOROLOGICAL DATA RECOVERY

Livingston, MT

Monitoring Period: **January 1 through December 31, 1991**

Variable	Total Periods	Total Measurements	Percentage Recovered
Temperature			
January	744	399	54%
February	672	672	100%
March	744	638	86%
Quarter	**2,160**	**1,709**	**79%**
April	720	720	100%
May	744	543	73%
June	720	606	84%
Quarter	**2,184**	**1,869**	**86%**
July	744	730	98%
August	744	446	60%
September	720	720	100%
Quarter	**2,208**	**1,896**	**86%**
October	744	589	79%
November	720	720	100%
December	744	744	100%
Quarter	**2,208**	**2,053**	**93%**
Year to Date	**8,760**	**7,517**	**86%**

METEOROLOGICAL DATA RECOVERY (cont.)

Livingston, MT

Monitoring Period: January 1 through December 31, 1991

Variable	Total Periods	Total Measurements	Percentage Recovered
Wind Speed			
January	744	399	54%
February	672	672	100%
March	744	638	86%
Quarter	**2,160**	**1,709**	**79%**
April	720	720	100%
May	744	544	73%
June	720	606	84%
Quarter	**2,184**	**1,870**	**86%**
July	744	730	98%
August	744	446	60%
September	720	720	100%
Quarter	**2,208**	**1,896**	**86%**
October	744	583	78%
November	720	720	100%
December	744	744	100%
Quarter	**2,208**	**2,047**	**93%**
Year to Date	**8,760**	**7,522**	**86%**

METEOROLOGICAL DATA RECOVERY (cont.)

Livingston, MT

Monitoring Period: **January 1 through December 31, 1991**

Variable	Total Periods	Total Measurements	Percentage Recovered
Wind Direction			
January	744	398	54%
February	672	671	100%
March	744	638	86%
Quarter	**2,160**	**1,707**	**79%**
April	720	720	100%
May	744	542	73%
June	720	606	84%
Quarter	**2,184**	**1,868**	**86%**
July	744	730	98%
August	744	446	60%
September	720	715	99%
Quarter	**2,208**	**1,891**	**86%**
October	744	581	78%
November	720	720	100%
December	744	743	99%
Quarter	**2,208**	**2,046**	**93%**
Year to Date	**8,760**	**7,512**	**86%**

VI. SUMMARY

PM10 data has been collected upwind and downwind of the Livingston Railyard for 14 consecutive months. Although there have been some gaps in the collection schedule, overall data recovery for the period has been more than 70% at both sites.

Comparison of ambient PM10 concentrations upwind and downwind of the Livingston Railyard has shown that activities at the site have not led to increases in particulate downwind. In fact, the average concentration of 14 months has shown that upwind concentrations are, on average, greater than downwind concentrations.

Of the 108 PM10 samples collected upwind and downwind of the site, none has exceeded 40% of the peak ambient standard or of the annual mean.

APPENDIX A

AIR QUALITY DATA

Bison Engineering Inc

Helena, MT 59601

PM10 Particulate Summary

1991 Site & Area: 1111 3

Upwind Site Livingston, MT Envirocon

(Values are in Micrograms per Cubic Meter)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	19	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	9
5	-	15	-	-	-	-	18	-	-	-	-	-
6	-	-	-	12	18	19	-	-	-	15	17	-
7	-	-	12	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	16
11	-	19	-	-	-	28	-	-	-	-	16	-
12	14	-	-	13	12	-	-	-	-	26	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	39	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	33
17	-	9	-	-	-	12	-	-	-	-	9	-
18	13	-	-	10	13	-	-	-	-	-	-	-
19	-	-	40	-	-	-	-	-	-	14	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	12
23	-	15	-	-	-	-	-	-	-	-	-	-
24	15	-	-	19	22	21	-	-	56	16	-	-
25	-	-	13	-	-	-	24	21	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	13
30	22	-	-	22	16	10	-	-	19	29	-	-
31	-	-	16	-	-	-	-	-	-	-	-	-
No.	4	4	6	5	5	5	2	1	2	5	3	5
Max	22	19	40	22	22	28	24	21	56	29	17	33
Avg	16	15	23	15	16	18	21	21	38	20	14	17

Bison Engineering Inc

Helena, MT 59601

PM10 Particulate Summary

1991 Site & Area: 1111 4

Downwind Site Livingston, MT Envirocon

(Values are in Micrograms per Cubic Meter)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	8	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	12	-	-	-	-	22	-	-	-	-	-
6	17	-	-	11	16	-	-	-	-	14	13	-
7	-	-	15	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
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19	-	-	20	-	-	-	-	-	-	14	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	10
23	-	13	-	-	-	-	-	-	-	-	10	-
24	9	-	-	19	15	18	-	-	-	14	-	-
25	-	-	8	-	-	-	28	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	11	13
30	24	-	-	22	-	18	-	-	22	23	-	-
31	-	-	15	-	-	-	-	-	-	-	-	-
No.	4	4	6	5	4	4	2	0	1	5	4	4
Max	24	18	28	22	16	34	28		22	30	13	17
Avg	16	14	16	13	12	22	25		22	19	12	14

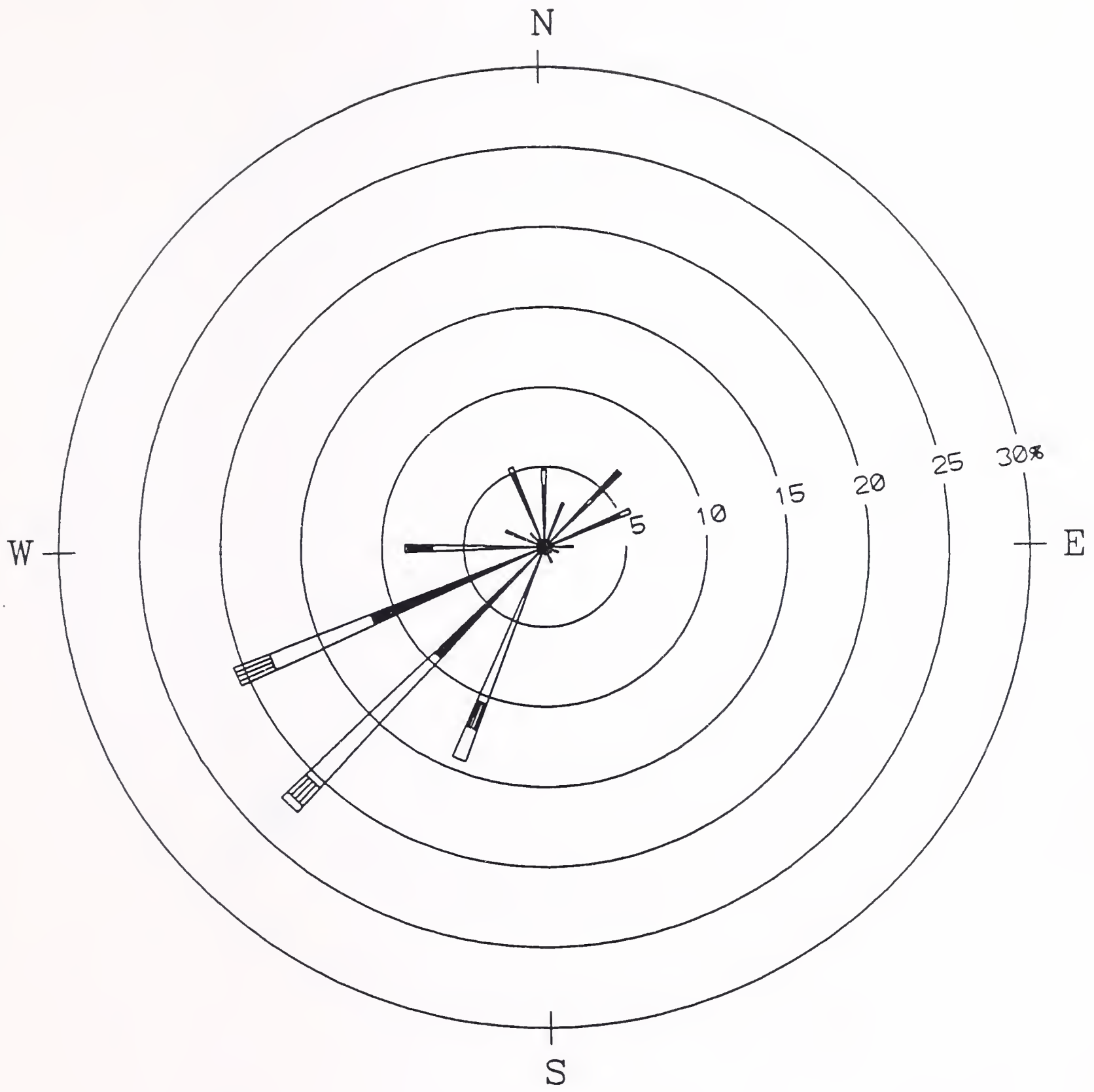
Bison Engineering Inc.
Helena, MT 59601

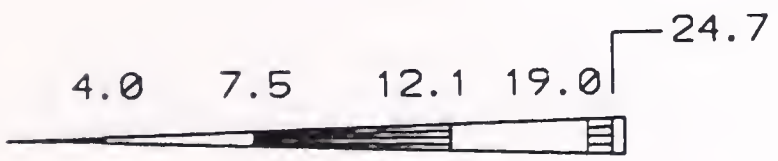
SUMMARY STATISTICS FOR THE PM10 PARTICULATE DATA

1991

Upwind Site Livingston, MT Envirocon

Site #	Min	Max	2nd Max	# > 150	Arith. Mean	Arith. Std Dev	Geo. Mean	Geo. Std Dev	Total # Obs.
3	9	56	40	0	19	9	17	1.5	47
4	5	34	30	0	16	7	15	1.5	43





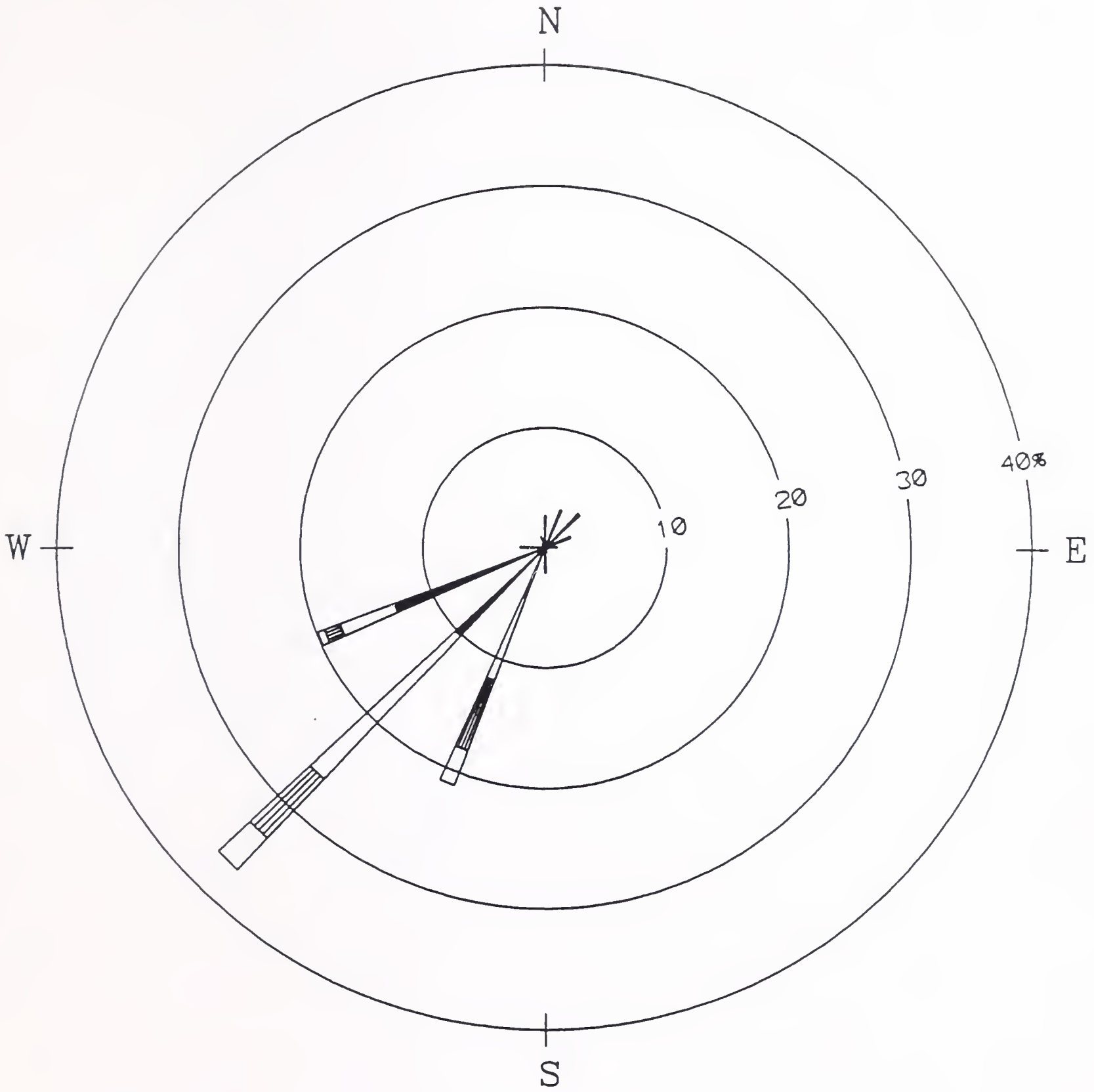
Wind Speed Class Boundaries
(Miles/Hour)

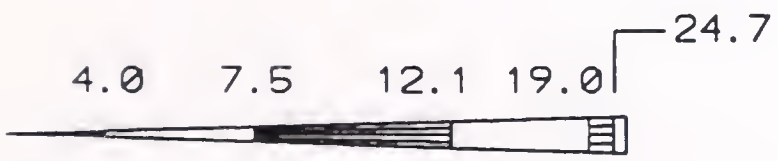
NOTES:
Diagram of the Frequency of Occurrence for each Wind Direction.
Wind Direction is the Direction From Which the Wind is Blowing.

WINDROSE

Livingston, MT
PERIOD: Oct. 1991

Bison
Engineering





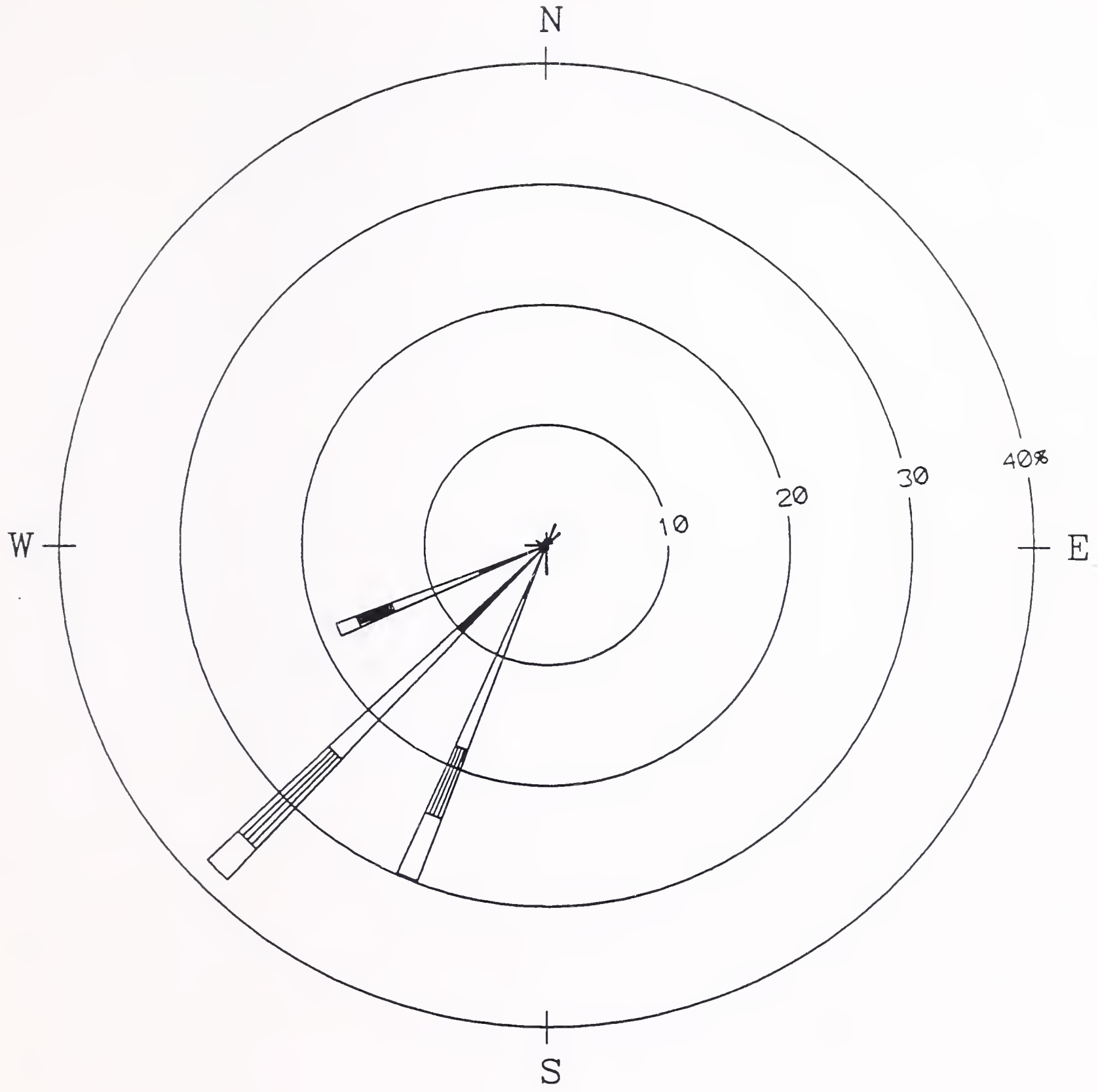
Wind Speed Class Boundaries
(Miles/Hour)

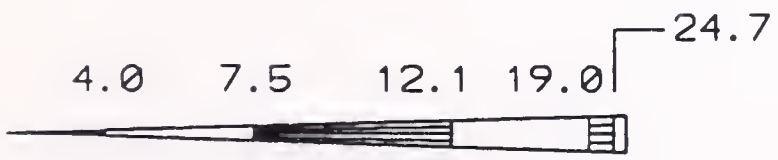
NOTES:
Diagram of the Frequency of Occurrence for each Wind Direction.
Wind Direction is the Direction From Which the Wind is Blowing.

WINDROSE

Livingston, MT
PERIOD: Nov., 1991

Bison
Engineering





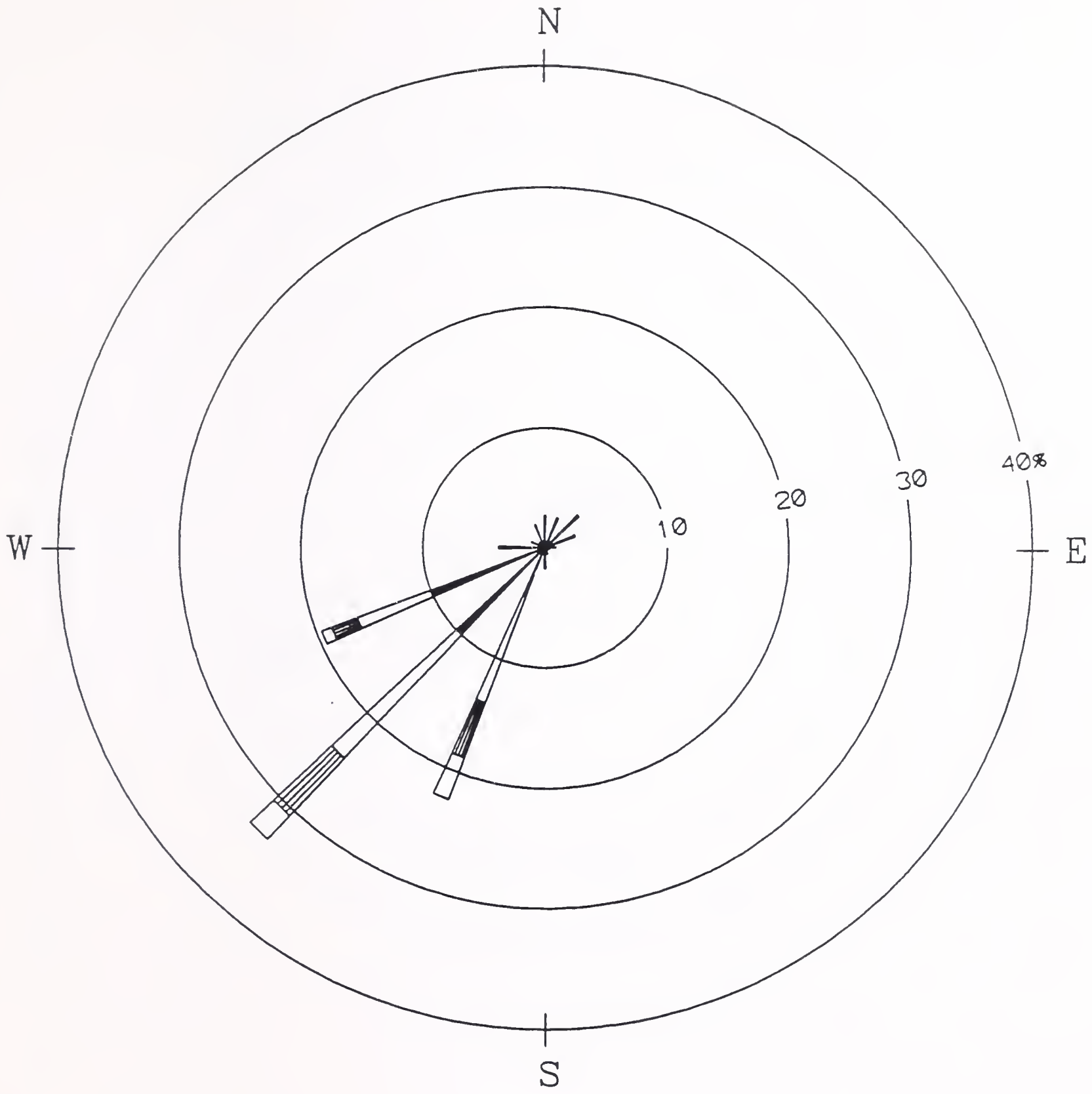
Wind Speed Class Boundaries
(Miles/Hour)

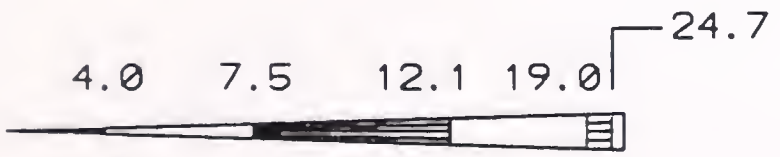
NOTES:
Diagram of the Frequency of Occurrence for each Wind Direction.
Wind Direction is the Direction From Which the Wind is Blowing.

WINDROSE

Livingston, MT
PERIOD: Dec. 1991

Bison
Engineering





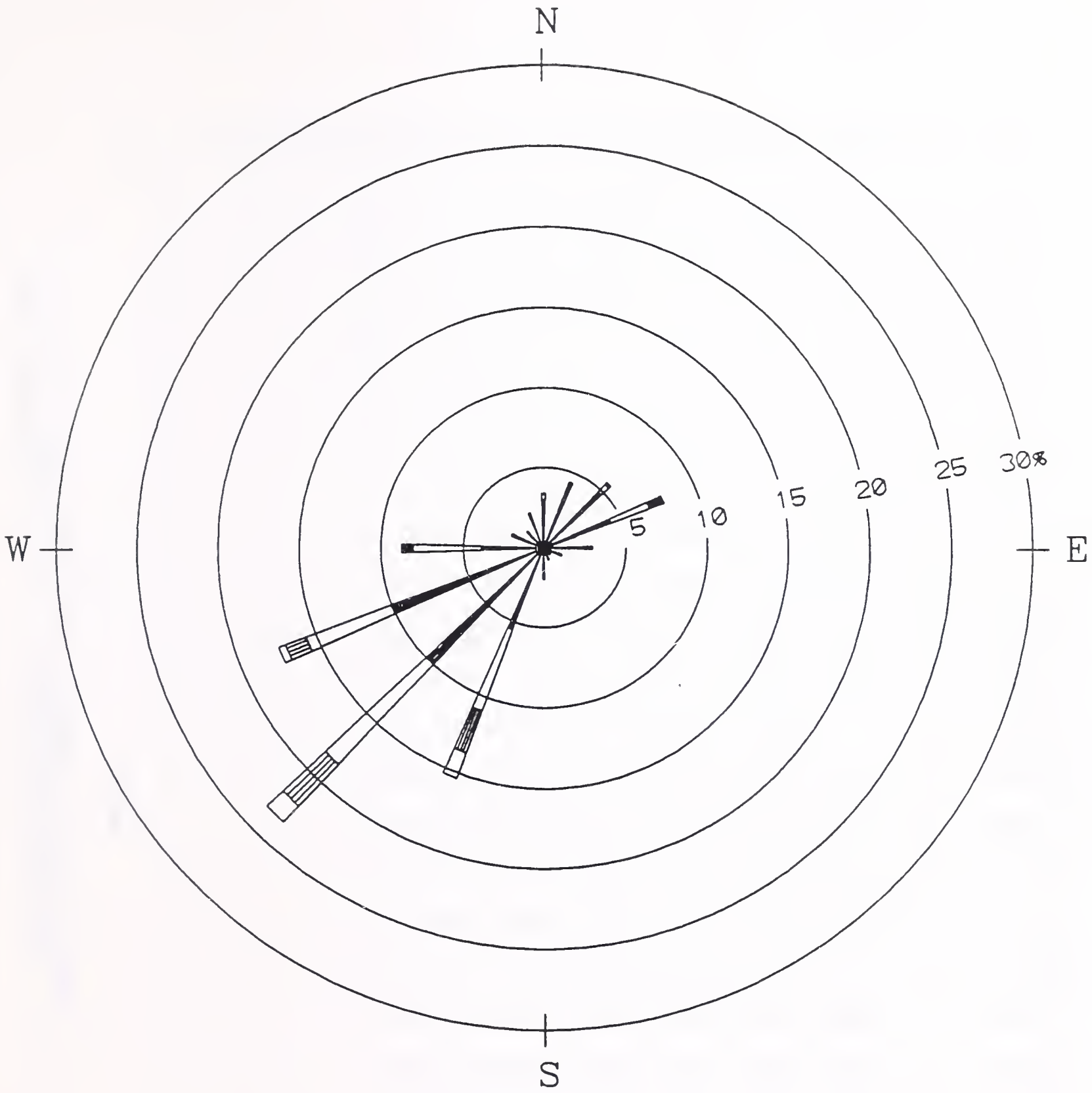
Wind Speed Class Boundaries
(Miles/Hour)

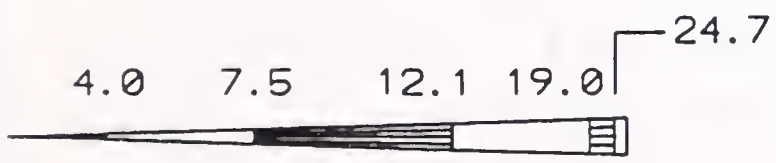
NOTES:
Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

WINDROSE

Livingston, MT
PERIOD: 4th Q 1991

Bison
Engineering





Wind Speed Class Boundaries
(Miles/Hour)

NOTES:
Diagram of the Frequency of Occurrence for each Wind Direction.
Wind Direction is the Direction From Which the Wind is Blowing.

WINDROSE

Livingston, MT
PERIOD: 1991

Bison
Engineering

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon — Livingston, Montana — OCTOBER 1991

*** *TEMPERATURE SUMMARY (DEG F)* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
7	-	-	-	-	-	-	-	-	-	-	66	70	73	73	72	73	72	70	68	66	64	63	61	55	68
8	54	50	50	50	48	48	46	48	54	59	63	64	66	68	68	68	68	64	59	55	52	50	48	46	56
9	48	48	52	50	50	48	50	52	55	59	63	64	68	70	70	70	68	66	63	59	59	59	59	57	59
10	57	57	59	57	57	57	55	57	59	61	66	70	73	77	77	77	75	72	66	63	63	61	59	59	64
11	59	59	59	59	54	48	57	57	59	61	66	70	73	77	81	81	81	73	64	63	57	55	48	50	63
12	57	63	61	61	61	59	59	61	61	64	68	72	75	77	77	75	73	70	70	66	64	61	59	57	65
13	55	54	52	48	46	45	41	43	48	52	57	57	59	59	61	63	63	61	59	55	48	46	48	50	53
14	52	52	52	55	54	52	52	54	55	59	64	66	68	70	72	73	72	70	68	64	64	59	59	57	61
15	59	57	55	55	55	55	57	59	61	63	68	72	75	79	79	79	79	75	73	70	68	68	66	64	66
16	64	66	64	64	64	64	63	66	68	70	73	75	77	79	79	79	77	75	73	72	72	70	66	55	70
17	52	52	48	48	50	50	48	45	45	46	45	46	48	48	46	46	46	43	39	39	37	37	37	36	45
18	36	37	37	36	36	34	32	36	37	41	45	46	48	48	46	48	50	52	50	52	52	52	52	50	44
19	50	48	48	48	48	46	48	48	48	50	52	52	52	54	54	54	54	50	48	46	46	45	43	43	49
20	43	43	43	41	41	41	43	43	45	48	52	57	59	61	63	63	63	59	59	59	54	54	52	52	51
21	52	50	50	52	50	52	52	52	55	57	61	63	64	64	66	64	63	63	63	63	63	63	61	57	58
22	54	46	43	39	37	36	32	30	28	28	27	27	28	27	27	27	25	25	23	23	23	25	25	23	30
23	21	21	21	21	21	21	21	21	23	25	28	30	34	34	32	34	30	28	28	28	27	27	30	28	27
24	28	30	30	30	30	30	32	32	34	37	37	39	39	39	39	39	39	37	37	37	37	36	36	37	35
25	36	36	36	36	36	36	36	37	32	32	32	32	-	32	32	45	43	39	36	37	37	39	34	30	36
26	30	32	32	32	32	32	32	30	30	30	30	32	32	32	32	32	30	30	30	28	28	27	23	23	30
27	23	19	19	18	18	18	16	16	16	16	16	18	16	16	16	14	14	14	14	14	14	12	12	10	16
28	10	10	9	10	10	9	9	10	12	18	16	19	19	19	27	16	16	14	14	14	14	14	12	10	14
29	9	7	7	5	3	3	3	5	9	14	14	14	14	16	16	16	14	10	7	7	5	3	-0	-2	8
30	-2	-4	-6	-8	-8	-9	-9	-6	-0	5	9	12	14	16	18	18	18	18	18	21	23	25	25	27	9
31	27	27	27	27	27	27	28	28	27	28	30	30	28	25	23	23	21	18	18	16	16	14	14	12	23
AVG.	41	40	39	39	38	38	38	39	40	43	46	48	50	50	51	51	50	48	46	45	44	43	41	40	

MINIMUM T = -9 MAXIMUM T = 81 AVERAGE T = 44 HOURS OF DATA = 589

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon — Livingston, Montana — NOVEMBER 1991

*** *TEMPERATURE SUMMARY (DEG F)* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	10	10	10	9	7	7	5	5	7	9	9	9	12	12	12	10	7	5	3	1	-0	-4	-4	-6	6
2	-6	-8	-8	-8	-6	-4	-8	-4	1	3	7	9	10	12	14	14	12	10	9	9	9	9	10	12	4
3	12	14	14	14	14	14	16	18	18	19	21	25	28	28	30	30	30	30	28	28	28	28	28	28	23
4	28	28	27	28	28	32	32	32	34	34	36	37	37	39	39	41	43	43	43	41	41	41	41	43	36
5	43	41	41	41	43	41	41	41	41	41	41	41	41	41	41	43	43	43	43	41	43	36	27	23	40
6	23	21	21	19	18	16	16	16	16	18	23	28	25	30	43	43	43	41	41	39	39	39	39	39	29
7	37	37	37	36	36	36	36	36	36	37	39	41	43	45	46	48	46	46	45	46	46	46	46	46	41
8	46	46	46	46	46	46	46	46	48	50	52	54	55	54	55	55	54	54	54	54	54	54	54	54	51
9	48	45	45	45	45	45	45	43	43	45	46	48	48	50	50	50	48	41	37	36	34	34	32	34	43
10	37	41	41	39	41	41	41	43	43	43	45	45	45	45	46	48	46	43	41	41	41	41	39	39	42
11	39	39	37	37	37	37	37	37	37	39	43	46	48	50	52	52	52	50	50	50	50	50	50	48	45
12	50	50	48	50	48	50	50	50	50	48	50	50	48	46	46	46	46	46	48	48	48	48	48	48	49
13	50	48	48	46	45	43	43	43	45	45	45	46	41	41	43	41	41	39	39	39	34	32	32	32	42
14	34	32	32	30	30	30	28	28	28	32	32	36	36	36	36	36	34	34	32	28	28	27	25	23	31
15	21	21	19	19	18	18	18	18	21	25	28	30	30	32	34	32	30	28	28	27	28	28	28	28	25
16	28	28	28	28	28	28	28	28	30	30	32	36	39	43	45	45	45	43	43	41	41	41	41	41	36
17	39	41	41	41	41	43	43	43	43	43	43	43	41	43	45	43	43	43	41	41	39	39	39	39	42
18	39	39	37	37	36	36	36	36	36	36	36	37	39	39	39	39	39	39	39	37	36	34	34	34	37
19	36	34	34	34	34	34	34	34	36	37	39	41	41	43	41	41	39	37	37	37	39	39	39	39	37
20	39	41	41	41	41	43	41	39	41	43	43	45	45	43	43	45	43	41	36	36	37	37	37	37	41
21	37	37	34	32	34	32	32	32	32	34	34	34	34	32	32	34	32	30	30	30	30	28	27	27	32
22	27	27	27	27	27	27	27	27	27	27	28	28	28	30	30	30	27	25	25	23	23	21	21	23	26
23	23	21	21	21	21	21	21	21	21	21	23	27	28	30	32	32	34	34	34	34	32	34	32	32	27
24	32	34	34	34	34	34	34	34	36	36	37	39	41	41	43	41	41	39	39	37	37	37	37	36	37
25	36	37	37	37	39	39	39	39	41	43	45	45	43	43	43	43	39	39	39	37	37	37	39	39	40
26	39	37	37	36	36	37	36	36	36	37	37	39	41	41	41	41	41	39	37	36	36	36	34	32	37
27	30	30	30	30	30	30	30	30	30	28	28	28	28	27	27	27	27	25	25	23	23	23	21	21	27
28	19	18	23	21	21	23	23	21	23	23	23	25	27	27	27	27	28	28	28	28	28	28	28	28	25
29	28	27	27	27	25	23	23	23	19	19	18	19	19	18	16	14	12	12	10	10	7	3	3	-0	17
30	-2	-0	5	5	5	5	5	7	7	9	9	10	12	14	16	18	18	18	18	18	16	16	18	16	11
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
AVG.	31	31	31	30	30	30	30	30	31	32	33	35	35	36	37	37	36	35	34	33	33	32	32	31	

MINIMUM T = -8 MAXIMUM T = 55 AVERAGE T = 33 HOURS OF DATA = 720

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon — Livingston, Montana — DECEMBER 1991

*** *TEMPERATURE SUMMARY (DEG F)* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	16	16	14	14	12	12	12	12	14	16	19	21	23	27	28	28	28	27	25	23	25	23	23	23	20
2	23	23	23	25	25	25	25	25	25	28	30	30	32	28	27	27	25	25	27	27	27	27	28	27	26
3	27	27	28	28	28	30	32	30	30	32	34	36	36	37	37	37	37	39	36	36	36	37	37	36	33
4	36	36	37	37	37	37	37	36	37	37	41	43	43	43	43	43	43	41	41	41	39	39	39	37	39
5	39	37	37	37	37	37	37	37	37	39	41	45	46	46	46	45	45	45	45	46	46	46	46	46	42
6	46	46	46	45	45	43	43	43	45	43	45	45	45	43	41	41	43	43	43	45	45	45	45	43	44
7	43	43	43	43	43	41	37	34	36	36	36	37	37	39	37	36	34	36	34	34	34	32	32	32	37
8	32	30	28	28	28	28	32	32	34	36	36	39	43	43	41	41	36	37	36	37	37	37	37	36	35
9	36	36	36	36	36	36	36	36	36	37	39	41	43	43	43	41	39	39	39	39	39	39	39	39	38
10	39	41	41	39	37	36	32	30	32	34	34	34	34	36	36	34	32	30	30	30	30	30	28	28	34
11	28	28	27	27	28	28	30	30	32	34	36	37	39	43	39	39	39	39	37	37	37	36	37	36	34
12	34	34	34	36	34	34	34	34	32	34	36	36	36	37	37	36	34	34	37	37	36	36	34	32	35
13	30	30	32	30	30	28	23	23	21	21	25	28	28	30	30	28	27	27	27	25	27	25	25	25	27
14	27	27	28	28	27	27	30	30	30	32	32	34	34	32	34	36	36	32	32	32	32	32	32	32	31
15	32	30	32	32	30	30	30	30	30	32	32	36	39	41	43	41	41	41	41	39	39	37	37	37	36
16	37	37	37	37	37	37	39	37	39	39	41	41	43	45	46	45	39	34	30	27	27	23	21	19	36
17	16	16	14	14	12	12	21	23	18	23	30	36	41	43	41	37	32	28	27	25	21	21	21	21	25
18	19	19	27	39	39	39	39	41	41	43	43	45	48	50	48	48	46	46	46	45	45	43	41	41	41
19	41	41	37	36	36	37	36	36	34	36	37	37	39	39	37	37	36	34	30	28	28	28	28	28	35
20	25	25	25	25	23	23	23	21	21	23	25	27	30	32	34	34	32	30	32	34	34	32	32	34	28
21	34	34	34	34	36	36	36	36	36	36	39	41	43	45	46	46	45	45	43	43	41	41	39	39	39
22	37	37	37	37	37	37	36	36	36	36	37	37	37	39	41	41	37	37	34	32	30	32	32	32	36
23	32	30	30	30	28	28	28	28	28	30	32	34	36	37	39	39	39	37	37	36	36	36	36	34	33
24	36	34	34	36	34	34	34	34	34	36	37	39	41	43	45	45	43	39	41	39	39	37	37	37	38
25	37	36	36	36	34	34	34	32	32	34	36	37	39	39	41	41	39	36	34	32	32	28	32	34	35
26	34	34	32	32	32	32	32	32	32	32	34	37	39	41	43	43	41	41	41	41	39	39	39	39	37
27	37	39	37	37	37	36	36	36	36	36	39	41	45	45	46	46	45	45	43	43	43	43	41	41	40
28	39	39	41	37	36	34	34	32	32	34	37	39	43	45	45	45	45	43	43	43	41	41	43	41	40
29	37	37	36	36	36	34	34	34	34	36	37	39	41	43	43	43	39	36	36	36	36	36	34	34	37
30	32	32	30	30	30	30	30	28	28	30	34	36	37	39	41	39	39	34	30	27	27	25	30	32	32
31	32	32	32	32	32	30	30	28	28	30	32	34	36	37	37	37	34	32	30	30	30	30	30	28	32
AVG.	33	32	32	33	32	32	32	31	32	33	35	37	39	40	40	39	38	36	36	35	35	34	34	34	

MINIMUM T = 12 MAXIMUM T = 50 AVERAGE T = 35 HOURS OF DATA = 744

BISON ENGINEERING INC.
HELENA, MONTANA

OCTOBER 1991

*** *WIND SPEED SUMMARY* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	14.0	13.0	9.0	7.0	9.0	8.0	15.0	14.0	17.0	14.0	16.0	12.0	10.0	4.0	11.6
8	3.0	4.0	6.0	6.0	5.0	9.0	5.0	8.0	7.0	11.0	11.0	16.0	18.0	15.0	12.0	13.0	11.0	10.0	4.0	5.0	5.0	4.0	6.0	8.0	8.4
9	10.0	9.0	11.0	12.0	10.0	10.0	12.0	14.0	12.0	13.0	14.0	16.0	20.0	20.0	18.0	17.0	12.0	8.0	9.0	9.0	10.0	10.0	12.0	12.0	12.5
10	12.0	13.0	14.0	14.0	15.0	14.0	15.0	16.0	17.0	16.0	14.0	14.0	13.0	19.0	17.0	17.0	11.0	8.0	10.0	11.0	12.0	12.0	11.0	10.0	13.5
11	9.0	7.0	5.0	8.0	6.0	5.0	12.0	11.0	15.0	13.0	11.0	13.0	13.0	10.0	10.0	7.0	4.0	7.0	8.0	10.0	3.0	4.0	4.0	4.0	8.3
12	7.0	11.0	9.0	9.0	12.0	13.0	12.0	13.0	15.0	16.0	15.0	12.0	15.0	21.0	22.0	24.0	18.0	13.0	17.0	15.0	15.0	10.0	9.0	7.0	13.8
13	9.0	11.0	11.0	9.0	9.0	9.0	5.0	2.0	2.0	2.0	5.0	19.0	19.0	18.0	16.0	14.0	10.0	7.0	5.0	2.0	6.0	3.0	9.0	10.0	8.8
14	10.0	10.0	12.0	15.0	14.0	14.0	14.0	15.0	15.0	16.0	22.0	22.0	19.0	17.0	22.0	22.0	19.0	14.0	12.0	10.0	10.0	9.0	9.0	10.0	14.7
15	11.0	11.0	11.0	10.0	9.0	11.0	19.0	20.0	21.0	21.0	13.0	17.0	19.0	22.0	21.0	15.0	16.0	15.0	18.0	17.0	15.0	18.0	21.0	15.0	16.1
16	12.0	16.0	16.0	15.0	15.0	19.0	23.0	27.0	28.0	28.0	30.0	29.0	31.0	27.0	22.0	23.0	22.0	19.0	23.0	24.0	24.0	24.0	25.0	15.0	22.4
17	19.0	21.0	17.0	18.0	20.0	18.0	20.0	10.0	12.0	14.0	13.0	14.0	11.0	13.0	13.0	10.0	10.0	11.0	8.0	7.0	6.0	7.0	4.0	4.0	12.5
18	4.0	6.0	5.0	12.0	12.0	9.0	10.0	12.0	11.0	16.0	14.0	17.0	17.0	18.0	19.0	16.0	9.0	13.0	14.0	18.0	15.0	12.0	13.0	13.0	12.7
19	14.0	13.0	13.0	11.0	14.0	11.0	12.0	11.0	13.0	15.0	17.0	16.0	15.0	16.0	18.0	15.0	11.0	9.0	7.0	9.0	10.0	12.0	11.0	13.0	12.8
20	12.0	13.0	14.0	14.0	14.0	17.0	17.0	18.0	17.0	17.0	15.0	21.0	21.0	20.0	18.0	17.0	13.0	9.0	10.0	11.0	8.0	8.0	10.0	13.0	14.5
21	17.0	15.0	15.0	15.0	15.0	17.0	20.0	17.0	20.0	22.0	23.0	26.0	25.0	22.0	23.0	25.0	28.0	25.0	27.0	31.0	28.0	25.0	24.0	14.0	21.6
22	15.0	11.0	11.0	7.0	6.0	7.0	7.0	6.0	8.0	9.0	11.0	13.0	11.0	11.0	12.0	11.0	11.0	9.0	10.0	8.0	9.0	7.0	11.0	12.0	9.7
23	10.0	8.0	5.0	4.0	4.0	2.0	3.0	2.0	2.0	3.0	3.0	3.0	3.0	8.0	11.0	13.0	12.0	10.0	11.0	11.0	12.0	11.0	14.0	12.0	7.4
24	7.0	11.0	17.0	17.0	15.0	13.0	13.0	10.0	11.0	13.0	19.0	20.0	21.0	20.0	19.0	19.0	17.0	18.0	17.0	19.0	19.0	17.0	17.0	16.0	16.0
25	16.0	16.0	13.0	14.0	17.0	14.0	16.0	15.0	-	-	-	-	-	-	-	17.0	11.0	14.0	14.0	9.0	6.0	7.0	7.0	7.0	12.5
26	7.0	13.0	12.0	12.0	13.0	12.0	9.0	11.0	10.0	8.0	7.0	6.0	8.0	10.0	8.0	11.0	13.0	12.0	13.0	13.0	9.0	8.0	5.0	3.0	9.7
27	5.0	11.0	10.0	10.0	8.0	10.0	10.0	12.0	11.0	11.0	10.0	7.0	10.0	9.0	9.0	9.0	7.0	5.0	3.0	3.0	4.0	5.0	5.0	4.0	7.8
28	2.0	5.0	3.0	5.0	3.0	2.0	3.0	2.0	1.0	2.0	4.0	4.0	4.0	4.0	2.0	3.0	3.0	3.0	3.0	1.0	2.0	4.0	4.0	6.0	3.1
29	7.0	7.0	5.0	6.0	4.0	3.0	3.0	2.0	2.0	2.0	6.0	8.0	8.0	8.0	10.0	10.0	10.0	9.0	7.0	9.0	9.0	6.0	3.0	5.0	6.2
30	4.0	4.0	2.0	2.0	2.0	4.0	4.0	3.0	10.0	13.0	12.0	13.0	13.0	15.0	12.0	14.0	11.0	13.0	14.0	16.0	14.0	15.0	18.0	22.0	10.4
31	20.0	24.0	26.0	23.0	18.0	15.0	15.0	10.0	5.0	3.0	3.0	3.0	8.0	14.0	12.0	9.0	8.0	13.0	8.0	8.0	5.0	3.0	3.0	5.0	10.9
AVG.	10.1	11.3	11.0	11.2	10.8	10.8	11.6	11.1	11.5	12.3	12.8	14.3	14.6	15.2	14.8	14.4	12.5	11.5	11.6	11.6	10.9	10.1	10.6	9.8	

# of Valid Hours = 583 % Data Completeness = 78.4

BISON ENGINEERING INC.
HELENA, MONTANA

NOVEMBER 1991

*** WIND SPEED SUMMARY ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	12.0	12.0	10.0	9.0	11.0	9.0	9.0	11.0	10.0	10.0	12.0	11.0	9.0	8.0	8.0	7.0	7.0	3.0	3.0	3.0	4.0	1.0	4.0	3.0	7.8
2	4.0	2.0	4.0	3.0	5.0	5.0	3.0	6.0	15.0	15.0	14.0	14.0	13.0	13.0	12.0	9.0	9.0	9.0	10.0	11.0	13.0	14.0	15.0	17.0	9.8
3	15.0	16.0	20.0	22.0	27.0	24.0	24.0	26.0	24.0	29.0	31.0	28.0	25.0	24.0	22.0	21.0	22.0	22.0	20.0	21.0	25.0	21.0	23.0	26.0	23.3
4	25.0	23.0	26.0	26.0	27.0	28.0	27.0	26.0	36.0	29.0	32.0	30.0	30.0	27.0	27.0	24.0	20.0	15.0	17.0	17.0	17.0	12.0	14.0	11.0	23.6
5	11.0	12.0	11.0	11.0	11.0	15.0	12.0	11.0	14.0	15.0	16.0	14.0	14.0	19.0	22.0	20.0	13.0	10.0	16.0	16.0	16.0	12.0	13.0	12.0	14.0
6	9.0	7.0	9.0	9.0	9.0	9.0	8.0	7.0	6.0	3.0	2.0	2.0	3.0	4.0	9.0	10.0	11.0	10.0	11.0	13.0	11.0	7.0	10.0	10.0	7.9
7	10.0	12.0	10.0	10.0	13.0	13.0	15.0	16.0	18.0	18.0	18.0	16.0	16.0	16.0	15.0	9.0	11.0	14.0	16.0	22.0	18.0	15.0	18.0	25.0	15.2
8	18.0	20.0	20.0	27.0	28.0	27.0	29.0	29.0	30.0	27.0	26.0	25.0	24.0	21.0	22.0	14.0	17.0	19.0	16.0	16.0	17.0	16.0	20.0	15.0	21.8
9	13.0	10.0	9.0	13.0	12.0	13.0	3.0	3.0	2.0	4.0	4.0	6.0	11.0	11.0	9.0	10.0	8.0	5.0	6.0	5.0	3.0	5.0	4.0	3.0	7.2
10	11.0	15.0	14.0	11.0	18.0	22.0	19.0	18.0	14.0	13.0	14.0	11.0	15.0	15.0	14.0	11.0	7.0	7.0	9.0	11.0	11.0	13.0	11.0	10.0	13.1
11	12.0	15.0	14.0	15.0	16.0	18.0	18.0	19.0	21.0	23.0	22.0	25.0	25.0	23.0	18.0	16.0	19.0	20.0	20.0	19.0	18.0	24.0	26.0	24.0	19.6
12	23.0	22.0	19.0	22.0	22.0	23.0	25.0	26.0	25.0	18.0	21.0	23.0	12.0	12.0	14.0	19.0	22.0	19.0	24.0	23.0	17.0	20.0	18.0	15.0	20.2
13	20.0	14.0	16.0	19.0	15.0	11.0	12.0	12.0	12.0	12.0	11.0	8.0	9.0	5.0	4.0	8.0	5.0	1.0	3.0	4.0	7.0	5.0	4.0	5.0	9.3
14	4.0	3.0	4.0	3.0	4.0	2.0	2.0	3.0	3.0	2.0	3.0	3.0	3.0	3.0	7.0	7.0	6.0	6.0	2.0	4.0	3.0	4.0	4.0	3.0	3.7
15	2.0	3.0	2.0	4.0	2.0	4.0	5.0	6.0	7.0	8.0	10.0	11.0	11.0	10.0	11.0	9.0	9.0	9.0	10.0	10.0	10.0	14.0	11.0	14.0	8.0
16	17.0	17.0	20.0	18.0	17.0	21.0	19.0	22.0	24.0	25.0	26.0	25.0	21.0	20.0	17.0	17.0	17.0	22.0	21.0	17.0	23.0	22.0	27.0	18.0	20.5
17	22.0	24.0	29.0	28.0	21.0	21.0	18.0	18.0	15.0	17.0	20.0	18.0	17.0	14.0	14.0	12.0	10.0	15.0	17.0	12.0	13.0	12.0	11.0	13.0	17.1
18	15.0	9.0	8.0	13.0	14.0	13.0	14.0	12.0	11.0	14.0	13.0	14.0	16.0	16.0	15.0	18.0	10.0	9.0	8.0	9.0	12.0	8.0	12.0	9.0	12.2
19	11.0	8.0	5.0	8.0	8.0	10.0	10.0	11.0	13.0	16.0	18.0	18.0	20.0	22.0	23.0	27.0	29.0	31.0	31.0	35.0	36.0	34.0	35.0	30.0	20.4
20	34.0	31.0	28.0	24.0	27.0	28.0	31.0	32.0	31.0	35.0	34.0	35.0	31.0	28.0	24.0	26.0	19.0	11.0	7.0	10.0	12.0	9.0	7.0	5.0	23.3
21	6.0	7.0	12.0	10.0	10.0	13.0	10.0	12.0	9.0	12.0	14.0	13.0	16.0	13.0	16.0	12.0	11.0	10.0	10.0	10.0	11.0	12.0	10.0	6.0	11.0
22	5.0	9.0	12.0	12.0	10.0	8.0	9.0	10.0	10.0	12.0	14.0	12.0	17.0	16.0	14.0	12.0	9.0	7.0	9.0	9.0	8.0	10.0	9.0	12.0	10.6
23	13.0	15.0	16.0	17.0	17.0	16.0	15.0	15.0	18.0	19.0	22.0	23.0	22.0	20.0	20.0	20.0	21.0	21.0	23.0	20.0	22.0	21.0	21.0	26.0	19.3
24	25.0	21.0	21.0	21.0	21.0	19.0	21.0	21.0	19.0	23.0	18.0	18.0	17.0	15.0	13.0	14.0	13.0	14.0	14.0	14.0	19.0	20.0	23.0	19.0	18.5
25	19.0	18.0	20.0	22.0	21.0	26.0	25.0	25.0	23.0	21.0	23.0	20.0	20.0	24.0	20.0	22.0	19.0	19.0	17.0	16.0	16.0	14.0	12.0	13.0	19.8
26	11.0	15.0	16.0	12.0	10.0	11.0	6.0	11.0	9.0	10.0	7.0	5.0	6.0	8.0	11.0	12.0	13.0	11.0	8.0	9.0	10.0	5.0	5.0	5.0	9.4
27	5.0	5.0	6.0	7.0	7.0	10.0	9.0	11.0	14.0	14.0	14.0	12.0	13.0	13.0	14.0	13.0	13.0	13.0	12.0	10.0	8.0	7.0	5.0	3.0	9.9
28	6.0	9.0	13.0	10.0	11.0	13.0	15.0	18.0	17.0	19.0	21.0	18.0	19.0	16.0	15.0	14.0	15.0	16.0	13.0	13.0	15.0	17.0	16.0	12.0	14.6
29	10.0	6.0	3.0	5.0	17.0	22.0	20.0	18.0	22.0	10.0	13.0	8.0	7.0	7.0	6.0	7.0	4.0	5.0	4.0	3.0	4.0	3.0	4.0	2.0	8.8
30	3.0	3.0	11.0	12.0	12.0	16.0	19.0	18.0	22.0	21.0	21.0	21.0	19.0	16.0	16.0	14.0	13.0	14.0	15.0	13.0	11.0	10.0	12.0	11.0	14.3
AVG.	13.0	12.8	13.6	14.1	14.8	15.7	15.1	15.8	16.5	16.5	17.1	16.2	16.0	15.3	15.1	14.5	13.4	12.9	13.1	13.2	13.7	12.9	13.5	12.6	

# of Valid Hours = 720 % Data Completeness = 100.0

BISON ENGINEERING INC.
HELENA, MONTANA

DECEMBER 1991

*** WIND SPEED SUMMARY ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	12.0	13.0	18.0	20.0	23.0	23.0	25.0	26.0	29.0	24.0	24.0	32.0	30.0	27.0	24.0	25.0	22.0	19.0	26.0	29.0	30.0	29.0	30.0	28.0	24.5
2	28.0	25.0	21.0	20.0	18.0	17.0	12.0	10.0	5.0	5.0	3.0	5.0	4.0	6.0	5.0	2.0	2.0	9.0	10.0	11.0	10.0	11.0	14.0	15.0	11.2
3	17.0	18.0	19.0	18.0	16.0	21.0	23.0	26.0	20.0	23.0	21.0	23.0	21.0	25.0	24.0	23.0	24.0	21.0	17.0	18.0	24.0	21.0	26.0	23.0	21.3
4	28.0	22.0	23.0	32.0	26.0	24.0	23.0	27.0	26.0	24.0	24.0	21.0	20.0	22.0	23.0	17.0	13.0	11.0	15.0	16.0	13.0	17.0	18.0	22.0	21.1
5	19.0	17.0	20.0	20.0	20.0	24.0	27.0	24.0	26.0	23.0	24.0	19.0	23.0	24.0	22.0	28.0	29.0	28.0	27.0	26.0	28.0	28.0	30.0	29.0	24.4
6	25.0	25.0	28.0	33.0	32.0	30.0	30.0	27.0	23.0	19.0	22.0	20.0	19.0	18.0	11.0	13.0	15.0	14.0	15.0	20.0	23.0	22.0	23.0	25.0	22.2
7	24.0	21.0	23.0	20.0	15.0	14.0	6.0	4.0	8.0	11.0	8.0	11.0	12.0	15.0	15.0	13.0	11.0	10.0	8.0	10.0	12.0	8.0	10.0	12.0	12.5
8	16.0	15.0	14.0	14.0	12.0	12.0	26.0	28.0	27.0	25.0	21.0	21.0	29.0	26.0	25.0	19.0	11.0	14.0	13.0	18.0	19.0	16.0	17.0	19.0	19.0
9	23.0	24.0	21.0	25.0	27.0	26.0	24.0	29.0	28.0	28.0	25.0	24.0	23.0	21.0	24.0	32.0	32.0	35.0	32.0	33.0	32.0	29.0	28.0	28.0	27.2
10	22.0	20.0	24.0	20.0	15.0	16.0	17.0	18.0	13.0	12.0	14.0	18.0	18.0	17.0	17.0	16.0	14.0	12.0	15.0	21.0	19.0	20.0	18.0	21.0	17.4
11	20.0	21.0	20.0	19.0	22.0	16.0	16.0	14.0	13.0	16.0	15.0	21.0	20.0	21.0	23.0	20.0	22.0	22.0	20.0	18.0	21.0	21.0	22.0	15.0	19.1
12	8.0	15.0	17.0	18.0	22.0	22.0	23.0	24.0	27.0	26.0	22.0	27.0	30.0	28.0	32.0	31.0	26.0	28.0	22.0	20.0	18.0	23.0	21.0	15.0	22.7
13	18.0	11.0	13.0	18.0	11.0	9.0	9.0	4.0	5.0	6.0	5.0	9.0	16.0	14.0	15.0	13.0	13.0	13.0	14.0	14.0	16.0	11.0	17.0	17.0	12.1
14	21.0	14.0	14.0	15.0	16.0	17.0	17.0	13.0	11.0	9.0	9.0	10.0	11.0	15.0	16.0	15.0	14.0	13.0	15.0	10.0	12.0	13.0	17.0	17.0	13.9
15	14.0	16.0	17.0	24.0	19.0	22.0	23.0	21.0	23.0	26.0	24.0	20.0	23.0	23.0	20.0	19.0	26.0	28.0	22.0	20.0	22.0	22.0	24.0	21.0	21.6
16	23.0	22.0	19.0	16.0	17.0	20.0	20.0	12.0	19.0	19.0	15.0	17.0	15.0	11.0	9.0	9.0	3.0	3.0	4.0	4.0	6.0	3.0	4.0	5.0	12.3
17	5.0	4.0	4.0	4.0	4.0	5.0	10.0	11.0	6.0	6.0	5.0	5.0	3.0	4.0	5.0	8.0	6.0	4.0	4.0	5.0	6.0	5.0	7.0	6.0	5.5
18	5.0	4.0	6.0	12.0	12.0	15.0	19.0	13.0	10.0	15.0	17.0	10.0	8.0	17.0	19.0	22.0	20.0	17.0	16.0	17.0	17.0	15.0	15.0	12.0	13.9
19	10.0	11.0	5.0	11.0	12.0	9.0	11.0	13.0	16.0	8.0	8.0	14.0	16.0	16.0	18.0	11.0	8.0	7.0	6.0	6.0	3.0	10.0	9.0	8.0	10.3
20	9.0	9.0	9.0	16.0	17.0	15.0	18.0	18.0	16.0	21.0	25.0	22.0	20.0	20.0	19.0	18.0	13.0	15.0	17.0	23.0	23.0	19.0	26.0	28.0	18.2
21	28.0	30.0	27.0	28.0	30.0	30.0	30.0	29.0	28.0	24.0	24.0	27.0	25.0	20.0	23.0	20.0	21.0	20.0	22.0	24.0	24.0	24.0	23.0	23.0	25.2
22	18.0	16.0	17.0	15.0	15.0	15.0	19.0	15.0	9.0	10.0	11.0	13.0	14.0	13.0	13.0	11.0	10.0	11.0	9.0	9.0	10.0	12.0	14.0	12.0	13.0
23	11.0	13.0	15.0	17.0	17.0	18.0	17.0	13.0	19.0	23.0	19.0	19.0	21.0	21.0	19.0	19.0	14.0	5.0	17.0	14.0	15.0	9.0	11.0	11.0	15.7
24	15.0	8.0	11.0	9.0	11.0	14.0	16.0	15.0	14.0	16.0	17.0	16.0	13.0	15.0	12.0	13.0	12.0	8.0	11.0	10.0	12.0	12.0	11.0	12.0	12.6
25	16.0	13.0	15.0	14.0	15.0	14.0	14.0	13.0	17.0	15.0	15.0	11.0	10.0	10.0	9.0	10.0	12.0	12.0	12.0	7.0	4.0	5.0	10.0	17.0	12.1
26	17.0	16.0	18.0	17.0	16.0	17.0	19.0	21.0	20.0	17.0	15.0	22.0	17.0	15.0	12.0	12.0	10.0	9.0	13.0	13.0	6.0	10.0	16.0	20.0	15.3
27	18.0	17.0	22.0	22.0	19.0	17.0	12.0	14.0	14.0	13.0	18.0	15.0	15.0	14.0	11.0	10.0	9.0	8.0	10.0	12.0	13.0	12.0	12.0	15.0	14.3
28	15.0	15.0	17.0	16.0	20.0	20.0	19.0	18.0	19.0	19.0	19.0	19.0	18.0	19.0	16.0	13.0	10.0	7.0	8.0	8.0	12.0	15.0	16.0	10.0	15.3
29	11.0	11.0	14.0	16.0	16.0	16.0	15.0	13.0	14.0	12.0	13.0	12.0	14.0	11.0	9.0	8.0	6.0	6.0	10.0	13.0	15.0	17.0	16.0	14.0	12.6
30	12.0	14.0	15.0	13.0	12.0	14.0	13.0	15.0	15.0	15.0	14.0	16.0	16.0	16.0	12.0	11.0	11.0	5.0	2.0	3.0	4.0	5.0	5.0	8.0	11.1
31	12.0	14.0	13.0	10.0	13.0	11.0	10.0	10.0	11.0	10.0	9.0	12.0	12.0	12.0	12.0	14.0	12.0	10.0	10.0	10.0	13.0	15.0	16.0	16.0	12.0
AVG.	16.8	15.9	16.7	17.8	17.4	17.5	18.2	17.4	17.1	16.8	16.3	17.1	17.3	17.3	16.6	16.0	14.5	13.7	14.3	14.9	15.5	15.5	17.0	16.9	

# of Valid Hours = 744 % Data Completeness = 100.0

BISON ENGINEERING INC.
HELENA, MONTANA

OCTOBER 1991

*** *WIND DIRECTION SUMMARY* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	212	207	204	313	275	239	209	206	204	229	223	243	246	353	223.5
8	229	164	202	241	268	263	276	231	269	226	244	267	276	282	282	287	251	253	32	210	208	230	213	231	254.4
9	244	245	229	238	240	247	235	220	221	214	215	243	262	260	260	263	252	229	234	229	248	246	238	242	267.7
10	240	237	224	231	230	227	220	221	213	216	221	223	230	260	258	263	260	242	224	236	248	249	248	241	255.6
11	243	228	213	217	170	109	226	193	198	218	215	210	205	204	201	269	134	236	206	230	98	127	30	139	225.9
12	230	202	207	227	222	222	234	228	211	214	207	220	244	260	257	260	268	299	280	286	304	307	301	256	259.5
13	264	249	227	234	233	269	75	149	154	75	232	251	250	251	252	252	230	247	241	123	334	248	246	247	215.4
14	241	241	226	223	222	226	228	231	227	231	256	260	254	260	255	268	259	249	245	223	225	231	242	241	216.5
15	226	236	246	236	239	236	239	226	201	204	208	214	222	258	259	245	233	223	213	217	220	213	208	226	250.3
16	245	214	205	206	203	202	200	208	208	209	206	206	202	234	237	242	239	242	257	246	245	256	271	294	264.5
17	293	288	309	295	271	271	275	-	355	340	350	356	346	359	3	16	4	37	64	48	17	43	38	342	343.5
18	259	279	275	261	245	247	287	267	224	263	259	272	279	277	280	280	264	266	267	275	286	255	241	234	334.0
19	250	249	239	241	258	272	280	271	262	255	257	269	258	244	249	255	254	254	241	237	245	251	243	238	281.7
20	227	237	218	216	222	219	214	217	219	222	229	256	254	265	257	253	238	238	254	252	230	219	245	221	243.8
21	229	251	258	242	240	227	218	217	214	214	206	218	209	207	209	205	210	209	211	211	210	208	205	247	214.2
22	253	356	2	37	78	356	55	35	23	22	4	357	349	50	65	60	47	41	47	58	62	57	58	62	52.1
23	58	61	42	34	44	339	317	352	234	231	251	203	219	231	238	234	238	248	244	245	248	245	228	232	59.7
24	200	202	211	202	207	235	204	219	237	208	221	218	220	218	227	219	211	208	203	204	204	208	205	213	205.2
25	211	208	220	231	221	220	213	210	-	-	-	-	-	-	-	210	218	245	270	248	233	241	59	33	210.7
26	36	60	72	73	82	86	85	74	68	61	52	44	57	62	56	61	68	72	67	64	54	35	49	58	70.3
27	352	332	337	338	335	324	337	343	337	346	347	345	356	1	-	355	356	341	1	334	329	68	71	352	5.4
28	20	49	354	341	38	108	95	27	306	274	301	331	66	91	336	323	301	251	86	111	149	44	29	40	28.0
29	37	28	6	45	41	40	348	19	40	348	48	66	53	42	46	50	42	38	7	8	29	29	340	196	32.8
30	203	226	161	51	67	35	84	91	226	236	232	209	209	208	215	216	233	231	232	226	217	232	232	223	213.1
31	226	236	235	234	216	215	224	229	186	115	172	342	342	339	344	348	19	354	8	359	340	154	88	13	243.9

# of Valid Hours = 581 % Data Completeness = 78.1

BISON ENGINEERING INC.
HELENA, MONTANA

NOVEMBER 1991

*** *WIND DIRECTION SUMMARY* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	351	358	26	7	22	24	14	29	5	4	358	354	2	357	356	336	311	248	216	15	203	190	208	247	0.7
2	222	226	17	51	7	6	63	190	219	217	218	214	213	220	229	237	250	250	250	249	241	236	231	232	242.7
3	233	223	212	218	201	207	203	202	211	208	209	220	225	219	223	220	223	219	216	214	217	233	227	221	221.5
4	220	209	220	228	220	212	235	230	226	248	247	230	222	225	226	244	247	242	219	214	220	231	234	226	224.0
5	238	234	232	229	243	221	210	209	210	207	210	208	237	218	225	227	221	244	217	217	210	25	55	76	223.8
6	26	56	49	47	50	47	51	33	19	359	27	234	189	23	269	236	233	239	229	231	232	226	231	229	224.5
7	235	236	242	243	235	235	224	232	220	209	212	228	240	230	233	240	232	224	253	241	244	235	225	212	225.1
8	216	240	230	218	222	237	248	249	224	208	205	206	216	213	215	232	240	216	223	215	217	210	205	207	225.5
9	263	241	229	232	238	228	359	186	182	199	17	231	259	248	251	256	258	41	37	51	125	298	289	200	234.6
10	218	203	207	210	214	222	227	226	227	231	227	224	237	242	243	244	208	237	244	235	243	242	236	233	239.7
11	222	209	209	208	214	212	211	218	222	223	223	217	210	206	220	235	236	233	226	241	231	228	220	216	229.0
12	213	211	223	208	214	213	218	209	207	210	210	211	241	243	228	217	201	213	209	211	227	213	214	225	223.7
13	215	228	215	212	216	238	220	205	234	223	211	263	359	95	48	270	281	260	201	320	13	351	184	198	228.0
14	255	169	218	181	208	206	40	43	344	348	59	85	99	85	51	44	29	12	13	175	183	179	196	197	116.5
15	237	225	181	204	236	212	203	228	233	226	214	212	225	215	216	232	236	239	242	248	238	223	233	231	148.4
16	220	227	211	208	205	187	197	196	197	196	190	187	193	199	202	214	216	219	214	205	197	199	207	197	194.2
17	209	207	220	205	202	202	206	208	204	213	216	225	220	209	217	221	230	214	206	225	230	236	241	255	203.2
18	246	243	248	236	243	250	252	246	257	260	252	243	254	252	242	247	258	259	247	235	264	239	248	239	248.5
19	231	244	245	249	258	249	243	238	228	196	226	228	225	219	210	212	213	207	216	221	216	208	219	208	231.6
20	211	206	208	201	195	204	209	209	208	209	210	205	207	210	207	206	205	248	121	230	224	237	238	211	194.1
21	245	241	244	230	247	235	221	230	222	231	240	261	268	246	241	243	238	239	238	238	241	249	238	233	140.5
22	231	241	254	257	262	246	264	239	238	249	253	263	256	260	255	244	235	242	238	234	239	249	239	238	136.2
23	228	217	224	220	224	222	221	211	204	203	205	209	239	239	223	226	219	234	228	228	243	236	228	235	127.1
24	230	229	222	216	213	242	239	227	209	205	233	217	213	230	222	220	214	216	224	221	222	215	211	214	150.7
25	229	236	228	241	253	218	229	225	223	224	216	217	198	203	199	219	222	224	214	218	225	211	216	243	211.2
26	238	238	237	244	244	251	278	243	244	255	214	196	90	213	222	232	234	249	237	233	220	200	189	66	231.3
27	62	34	39	44	50	57	50	50	51	54	51	58	77	78	66	63	67	66	65	53	33	20	15	164	63.3
28	223	232	220	238	237	219	224	204	212	210	220	233	216	226	223	231	237	229	228	232	232	216	224	210	83.5
29	200	258	209	55	354	340	339	349	342	2	43	305	199	18	44	358	63	105	82	80	24	61	214	215	5.8
30	205	158	239	234	227	220	222	225	213	219	210	219	223	229	223	221	229	225	219	232	230	240	233	231	231.0

# of Valid Hours = 720 % Data Completeness = 100.0

BISON ENGINEERING INC.
HELENA, MONTANA

DECEMBER 1991

*** *WIND DIRECTION SUMMARY* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	224	217	219	230	226	211	210	228	249	236	230	237	238	228	239	249	233	211	216	218	210	213	209	209	223.3
2	211	214	215	208	205	208	207	195	228	238	231	246	289	321	289	131	206	237	228	236	222	232	243	228	219.5
3	223	217	215	219	231	233	240	243	235	228	238	234	230	223	233	227	229	231	217	251	255	224	203	215	232.3
4	220	239	233	220	222	230	223	242	225	232	230	220	217	215	213	228	239	237	235	233	220	220	231	244	235.5
5	236	242	226	235	240	253	244	238	257	246	216	211	221	218	216	215	214	212	209	208	211	207	211	208	243.9
6	210	205	214	212	207	206	206	209	216	218	215	216	219	227	237	251	248	241	235	216	214	214	214	207	249.2
7	203	204	203	217	234	236	338	105	220	231	234	205	216	218	212	208	213	222	219	232	222	232	222	209	255.1
8	231	223	213	238	230	246	201	208	218	216	229	231	244	254	256	268	296	245	243	261	269	251	213	203	259.4
9	202	204	194	211	218	217	224	215	210	216	217	216	208	207	213	209	217	217	216	217	211	210	213	209	246.4
10	225	244	268	263	256	246	238	238	241	239	238	248	248	244	247	257	269	251	229	235	235	226	252	232	270.1
11	240	237	233	233	221	240	240	246	228	232	217	214	220	205	192	201	225	226	227	224	234	222	220	229	268.8
12	230	203	209	202	200	191	191	195	192	198	214	207	213	214	206	207	214	258	254	257	254	245	250	246	223.0
13	245	213	237	253	243	288	338	20	44	53	90	247	242	232	231	243	255	249	227	235	226	224	215	240	181.4
14	222	231	253	257	254	255	248	254	259	248	242	230	238	251	249	250	258	252	219	243	223	208	203	212	179.8
15	226	216	212	220	226	218	214	214	210	210	224	230	243	239	220	232	223	223	211	213	210	209	217	211	174.4
16	215	221	227	229	218	229	230	209	205	207	212	210	210	221	226	228	209	52	336	215	224	19	6	10	80.7
17	2	-	5	14	13	51	155	36	30	36	46	61	232	247	49	63	69	34	31	4	9	20	35	4	28.8
18	27	32	131	199	207	202	198	195	201	202	204	254	289	235	225	218	209	211	213	208	201	205	204	216	83.1
19	244	238	295	275	258	245	233	252	259	231	256	251	249	247	238	243	242	317	322	335	285	228	265	256	159.6
20	262	264	245	226	221	223	230	233	231	212	207	210	215	210	209	205	225	237	223	211	211	210	195	201	160.3
21	214	234	246	228	243	229	229	233	225	238	215	228	230	246	241	226	229	238	234	222	220	227	217	224	163.4
22	234	233	232	218	247	229	224	223	218	236	215	227	217	221	221	222	237	233	242	247	247	231	223	230	175.6
23	220	217	209	211	215	214	213	218	213	210	215	214	205	206	206	212	205	168	203	198	191	206	201	207	166.6
24	189	211	222	211	192	207	223	221	207	201	199	214	218	219	216	225	235	263	242	232	224	227	239	236	174.1
25	227	225	226	223	216	209	207	215	201	194	190	200	213	209	223	228	231	244	249	214	70	45	220	220	185.5
26	208	219	218	228	222	208	214	214	204	204	199	187	189	188	190	201	216	220	213	207	148	203	224	218	181.3
27	206	200	192	198	199	211	225	204	200	203	191	192	184	187	191	207	204	204	199	199	210	212	216	212	180.9
28	211	207	198	208	200	206	208	201	204	212	212	208	195	189	183	179	183	182	253	267	240	219	220	242	180.5
29	235	273	227	212	238	227	219	230	218	226	228	220	209	229	252	250	239	234	223	223	213	208	205	198	185.9
30	194	197	198	207	205	204	202	196	193	201	206	204	204	203	207	222	227	45	32	29	18	33	232	218	202.9
31	211	220	222	228	222	226	228	217	220	214	217	215	221	217	227	249	243	256	242	240	230	227	223	219	226.8

# of Valid Hours = 743 % Data Completeness = 99.9

BISON ENGINEERING INC.
HELENA, MONTANA

OCTOBER 1991

**** WIND FREQUENCY SUMMARY ****

DIR---> / SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0 - 4.0	0.9	1.2	1.5	0.7	1.2	0.7	0.5	1.0	0.2	0.3	1.0	0.7	0.2	0.3	0.5	1.7	12.7
4.0 - 7.5	0.9	0.9	2.6	1.0	0.0	0.2	0.0	0.0	0.3	1.2	0.9	1.0	1.0	0.0	0.2	0.9	11.0
7.5 - 12.1	2.1	0.9	2.4	3.3	0.3	0.0	0.0	0.0	0.0	1.4	7.6	9.8	1.9	0.5	0.3	2.4	32.8
12.1 - 19.0	1.0	0.0	0.0	0.7	0.2	0.0	0.0	0.0	0.0	7.6	11.0	6.7	3.8	1.5	0.2	0.3	33.0
19.0 - 24.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.5	2.4	1.5	0.2	0.0	0.0	7.4
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.5	0.0	0.2	0.0	0.0	0.0	2.7
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	4.8	2.9	6.5	5.7	1.7	0.9	0.5	1.0	0.5	14.6	22.5	20.6	8.6	2.6	1.2	5.3	
AVG. SPEED	8.7	5.7	6.7	8.8	5.7	2.6	4.0	2.5	4.7	16.7	13.3	13.1	14.6	13.1	7.3	7.4	

Calm Hours = 0.0% Total Hours With Both Speed and Direction = 582 Average Wind Speed = 11.9 (MPH)

Resultant Windspeed = 7.4 (MPH) Resultant Wind Direction = 238.8 Deg Wind Persistance = 62.3 %

BISON ENGINEERING INC.
HELENA, MONTANA

NOVEMBER 1991

*** *WIND FREQUENCY SUMMARY* ***

DIR---> / SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0 - 4.0	0.3	1.0	0.6	0.6	0.7	0.0	0.1	0.4	1.4	1.9	1.1	0.6	0.1	0.1	0.1	0.3	9.3
4.0 - 7.5	0.6	1.3	1.5	0.3	0.3	0.3	0.0	0.0	0.3	1.1	1.0	1.0	0.3	0.1	0.1	0.1	8.2
7.5 - 12.1	1.7	1.1	1.1	0.6	0.0	0.0	0.0	0.0	0.0	1.4	8.1	11.7	1.0	0.0	0.1	0.0	26.7
12.1 - 19.0	0.1	0.0	0.7	0.8	0.0	0.0	0.0	0.0	0.0	7.4	16.3	4.7	0.7	0.0	0.0	0.1	30.8
19.0 - 24.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	6.3	6.8	1.4	0.0	0.0	0.0	0.4	15.0
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	3.1	3.6	0.6	0.0	0.0	0.0	0.0	7.5
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.7	0.1	0.0	0.0	0.0	0.0	2.5
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	2.6	3.3	3.9	2.2	1.0	0.3	0.1	0.4	2.1	22.8	37.5	20.0	2.1	0.3	0.4	1.0	
AVG. SPEED	8.7	6.6	7.9	9.3	3.9	6.0	3.0	3.0	7.5	18.7	16.4	12.4	10.1	4.5	6.3	13.4	

Calm Hours = 0.0% Total Hours With Both Speed and Direction = 720 Average Wind Speed = 14.5 (MPH)

Resultant Windspeed = 11.7 (MPH) Resultant Wind Direction = 223.2 Deg Wind Persistance = 81.0 %

BISON ENGINEERING INC.
HELENA, MONTANA

DECEMBER 1991

**** WIND FREQUENCY SUMMARY ****

DIR---> / SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0 - 4.0	0.4	1.3	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.3	0.4	0.1	0.0	0.3	0.0	0.1	3.5
4.0 - 7.5	0.7	0.5	1.2	0.3	0.1	0.0	0.1	0.3	0.1	0.1	0.5	0.4	0.0	0.3	0.4	0.3	5.4
7.5 - 12.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.4	4.3	9.1	5.4	0.9	0.4	0.0	0.1	21.1
12.1 - 19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	13.6	14.4	7.7	0.5	0.0	0.0	0.0	37.6
19.0 - 24.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	6.0	10.2	3.1	0.3	0.0	0.0	0.0	20.0
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	3.5	1.7	0.0	0.0	0.0	0.0	10.8
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.7	0.1	0.0	0.0	0.0	0.0	1.6
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.1	1.9	1.5	0.5	0.1	0.1	0.3	0.4	2.4	30.6	38.8	18.5	1.7	0.9	0.4	0.5	
AVG. SPEED	4.9	4.1	5.7	5.7	5.0	4.0	4.0	7.0	15.5	18.8	17.2	15.9	13.8	6.4	6.3	6.2	

Calm Hours = 0.0% Total Hours With Both Speed and Direction = 744 Average Wind Speed = 16.4 (MPH)

Resultant Windspeed = 15.0 (MPH) Resultant Wind Direction = 221.0 Deg Wind Persistance = 91.3 %

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon Livingston, Montana OCTOBER 1991

*** *WIND SIGMA SUMMARY (DEGREES)* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
7	-	-	-	-	-	-	-	-	-	-	18	14	21	56	21	46	12	16	13	26	17	14	12	57	25
8	88	82	29	14	16	36	59	43	62	17	25	13	12	15	17	17	10	9	60	40	60	50	22	14	34
9	10	11	16	10	12	9	14	15	15	16	16	17	9	11	11	10	14	15	10	10	9	10	11	11	12
10	11	11	14	14	10	12	11	12	11	12	13	16	18	11	11	10	10	8	10	10	8	10	11	9	11
11	30	16	40	15	71	68	14	18	11	26	44	12	10	10	16	66	90	39	14	13	82	73	41	75	37
12	41	17	46	34	12	14	12	16	14	14	13	25	22	14	12	16	11	26	11	21	12	16	24	21	19
13	14	20	9	12	16	52	50	51	66	61	71	12	13	12	14	14	23	10	60	71	18	54	9	12	31
14	13	15	19	17	13	12	13	14	16	19	12	11	16	15	12	12	12	11	12	9	7	10	9	13	13
15	15	12	10	14	19	21	15	13	14	13	27	14	23	11	15	21	15	18	16	13	15	14	12	20	16
16	21	17	15	13	15	13	11	11	11	11	12	12	11	19	14	13	15	18	10	12	13	12	13	22	14
17	14	14	19	21	9	8	8	-	24	14	13	13	34	16	14	17	15	27	16	21	18	15	19	31	17
18	21	20	16	8	11	10	19	24	16	14	16	12	10	9	8	8	16	12	9	8	11	14	12	12	13
19	11	12	12	20	10	13	12	13	11	10	10	10	10	13	12	12	12	9	8	12	10	8	10	10	11
20	15	13	14	13	13	10	11	12	12	14	14	13	13	11	12	12	11	15	10	11	17	20	11	11	13
21	12	13	15	17	18	13	14	18	15	12	13	11	12	13	13	12	11	12	11	11	11	11	11	64	15
22	25	19	24	43	50	34	44	57	22	20	16	12	13	19	12	13	13	14	12	12	17	17	13	14	22
23	11	11	21	26	18	42	48	70	76	62	51	52	43	17	9	10	8	9	8	9	9	9	14	21	27
24	62	34	12	9	12	18	15	25	40	14	13	12	12	12	11	10	12	10	11	10	10	12	11	13	17
25	12	12	18	16	15	12	14	14	-	-	-	-	-	-	-	13	18	22	10	25	28	27	38	21	19
26	30	12	15	19	13	11	14	11	10	13	14	16	12	11	13	11	11	11	11	10	13	28	34	25	15
27	24	14	18	19	17	16	15	15	14	14	14	30	13	12	-	13	20	23	19	16	47	34	15	36	20
28	60	64	55	24	40	22	18	67	18	44	17	19	42	20	73	23	10	39	80	68	77	18	17	10	39
29	16	15	21	30	15	17	20	35	36	46	20	14	16	16	14	12	14	24	14	9	13	23	53	13	21
30	13	17	51	30	61	35	58	44	36	11	15	11	11	10	13	11	13	9	9	10	11	10	9	10	21
31	18	11	12	12	13	14	13	12	65	34	70	48	20	14	16	18	38	27	30	22	35	71	52	54	30
AVG.	24	20	22	19	21	21	22	27	27	22	23	17	17	15	16	17	17	17	19	19	23	23	19	24	

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon Livingston, Montana NOVEMBER 1991

*** *WIND SIGMA SUMMARY (DEGREES)* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	13	14	12	14	15	14	13	13	15	13	12	11	15	12	9	14	10	48	39	45	21	60	16	77	22
2	29	64	51	38	81	78	33	70	10	11	11	10	13	12	13	16	12	9	9	9	9	9	9	10	26
3	12	16	13	12	10	11	11	11	13	11	11	12	13	11	10	11	11	10	11	11	11	14	14	11	12
4	16	11	11	14	18	12	20	20	19	12	11	18	17	18	23	13	14	19	13	17	14	17	12	11	15
5	10	7	15	10	20	18	14	12	11	13	16	13	24	14	12	12	15	19	13	13	13	-	19	23	15
6	24	37	17	17	16	17	15	12	22	25	49	72	81	52	44	11	12	11	13	10	12	13	8	11	25
7	10	8	9	9	9	14	12	13	13	16	19	22	18	18	23	27	21	19	18	18	19	26	21	17	17
8	21	23	27	20	14	17	11	12	14	10	11	13	16	16	18	22	17	16	18	16	14	13	12	14	16
9	15	28	17	14	15	15	85	44	56	39	47	48	10	11	12	10	25	-	15	14	63	19	53	65	31
10	18	13	43	33	13	11	13	12	15	12	11	12	11	12	15	17	34	17	13	13	12	11	10	14	16
11	13	11	12	12	11	10	10	11	13	13	16	13	16	14	18	18	16	16	19	16	17	16	16	12	14
12	12	13	17	14	15	13	15	13	14	14	13	13	24	13	13	16	15	18	15	13	18	16	14	13	15
13	11	19	16	14	18	22	25	19	23	24	15	63	34	30	71	19	55	31	23	45	41	50	23	30	30
14	52	59	42	32	23	43	54	38	31	56	16	16	19	35	21	14	12	21	75	11	17	14	14	19	31
15	72	25	83	15	43	25	20	17	15	16	13	11	15	15	14	12	13	8	10	12	13	13	14	12	21
16	11	14	12	12	15	11	11	11	12	12	11	10	12	13	12	13	18	12	15	15	14	14	12	20	13
17	15	16	13	14	13	12	17	17	20	24	17	19	18	15	18	16	19	19	12	18	18	19	14	20	17
18	15	28	33	13	11	17	10	10	12	9	10	12	12	11	12	10	9	14	11	14	23	18	12	10	14
19	17	16	24	12	14	22	14	15	27	10	15	12	14	12	13	14	13	14	14	13	12	13	12	13	15
20	13	14	13	15	13	12	12	13	13	12	12	11	12	12	12	12	16	74	67	11	11	37	41	34	21
21	20	13	16	43	45	29	12	13	14	11	12	19	11	16	10	11	8	10	12	9	10	9	9	51	17
22	32	19	11	8	25	20	14	8	11	9	9	26	9	10	10	13	9	9	6	8	14	14	9	12	13
23	12	11	9	12	14	13	15	14	12	12	11	11	24	16	17	18	13	20	16	15	14	13	14	11	14
24	13	16	16	11	13	16	15	16	15	12	23	14	14	20	12	13	12	17	14	13	11	12	14	14	14
25	16	19	15	16	15	16	17	13	15	15	17	17	15	12	18	17	18	19	15	13	11	14	15	14	16
26	13	10	10	9	10	13	52	11	14	12	25	41	79	18	13	11	17	23	27	12	16	22	29	21	21
27	15	11	13	11	14	10	12	11	11	11	11	11	9	9	9	9	9	8	10	11	20	17	81	50	16
28	29	16	11	12	12	13	15	11	12	10	17	15	11	17	12	15	10	11	15	14	12	13	12	10	14
29	11	30	48	39	14	12	11	12	9	52	33	75	76	22	27	17	50	16	31	55	36	44	20	63	33
30	50	77	9	9	12	11	10	14	11	12	11	16	10	14	11	13	15	11	9	12	12	10	18	14	16
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
AVG.	20	22	21	17	19	18	20	17	16	17	17	22	22	17	17	14	17	19	19	17	18	19	19	23	

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon Livingston, Montana DECEMBER 1991

*** *WIND SIGMA SUMMARY (DEGREES)* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	14	14	16	18	13	10	14	17	16	18	21	15	20	21	20	21	14	19	20	17	19	17	15	16	17
2	13	13	12	12	12	12	15	15	33	28	20	28	57	41	30	77	54	22	13	12	13	13	15	16	24
3	12	16	11	12	21	19	17	15	18	15	11	15	16	19	18	14	17	16	21	18	13	21	16	26	17
4	16	16	28	18	16	16	14	10	17	15	22	16	13	15	15	16	17	24	19	11	14	17	19	16	17
5	21	19	17	15	17	14	14	15	17	17	17	17	15	14	13	11	11	13	12	11	10	11	11	12	14
6	16	15	15	14	13	11	11	13	14	13	13	13	15	16	16	13	11	17	19	13	13	13	13	12	14
7	12	12	12	16	23	13	58	78	24	13	22	13	27	17	16	14	19	22	20	21	14	21	23	28	22
8	14	11	11	12	18	17	14	12	12	16	16	14	15	11	11	11	25	10	11	11	9	12	21	11	14
9	9	12	13	20	18	14	21	14	13	11	14	17	14	14	15	12	13	12	12	12	13	14	14	12	14
10	22	17	11	9	11	10	9	9	11	19	12	12	12	13	10	11	9	18	12	15	21	17	32	17	14
11	12	15	15	17	18	17	18	15	21	20	17	12	16	15	16	14	16	13	13	20	13	12	14	18	16
12	36	17	25	14	13	13	15	14	10	12	17	12	11	12	11	12	26	11	10	9	17	9	10	14	15
13	13	25	11	14	14	46	39	68	49	34	51	54	9	11	9	9	9	12	12	9	8	26	12	14	23
14	17	23	21	12	10	12	10	11	14	16	14	14	17	11	13	13	24	14	12	8	15	12	10	10	14
15	13	10	11	14	19	12	10	11	10	10	28	21	15	15	13	12	10	10	11	15	12	13	13	10	13
16	10	11	17	14	10	9	10	18	11	14	19	15	20	21	20	13	67	85	58	18	34	51	21	23	25
17	25	-	21	26	26	22	76	83	33	30	40	76	84	79	27	23	23	28	22	22	23	24	29	21	38
18	21	32	73	12	30	18	11	14	25	15	16	37	51	41	14	13	13	14	13	12	13	14	10	25	22
19	25	20	71	59	10	13	9	12	8	39	52	10	10	11	11	15	11	79	38	61	59	28	11	12	28
20	11	10	17	10	9	10	12	11	15	9	10	11	14	11	12	13	21	14	14	14	11	13	11	10	12
21	15	13	13	20	14	15	14	13	15	14	19	12	12	13	13	16	15	12	12	12	12	12	11	10	14
22	12	16	20	11	11	12	13	13	24	22	13	12	13	14	10	19	13	12	10	8	7	9	9	15	13
23	16	12	10	11	11	10	11	13	10	10	12	12	10	10	12	10	11	65	11	12	11	17	14	13	14
24	14	28	13	23	17	13	12	12	12	11	11	12	14	12	13	14	18	20	17	16	15	9	11	9	14
25	11	15	11	13	11	12	12	12	12	12	12	14	14	13	15	12	14	9	8	34	68	70	34	12	19
26	10	16	13	13	10	11	10	9	10	12	17	10	12	13	14	10	19	16	14	14	82	65	12	10	18
27	11	11	10	9	12	12	19	20	19	19	15	15	13	12	13	13	14	20	13	13	13	15	17	12	14
28	12	14	13	13	9	10	11	15	13	12	11	11	12	10	10	11	12	64	63	38	28	17	26	23	19
29	22	19	19	15	15	12	10	12	9	12	14	16	14	25	17	13	17	25	18	16	16	15	14	14	16
30	15	12	11	14	13	14	12	10	10	12	13	13	13	13	14	21	19	50	69	28	51	41	77	22	24
31	12	14	14	12	11	13	11	13	10	12	14	14	17	16	17	10	9	8	10	11	10	11	11	11	12
AVG.	16	16	19	16	15	14	17	19	17	17	19	18	19	18	15	16	18	24	20	17	21	21	18	15	

BISON ENGINEERING INC
HELENA, MONTANA

Envircon Livingston, Montana 4th Q 1991

*** *WIND FREQUENCY SUMMARY* ***

DIR---> / SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0 - 4.0	0.5	1.2	0.7	0.4	0.6	0.2	0.2	0.4	0.5	0.9	0.8	0.4	0.1	0.2	0.2	0.6	8.2
4.0 - 7.5	0.7	0.9	1.7	0.5	0.1	0.1	0.0	0.1	0.2	0.8	0.8	0.8	0.4	0.1	0.2	0.4	8.0
7.5 - 12.1	1.2	0.6	1.1	1.2	0.1	0.0	0.0	0.0	0.1	2.4	8.3	8.8	1.2	0.3	0.1	0.7	26.4
12.1 - 19.0	0.3	0.0	0.2	0.5	0.0	0.0	0.0	0.0	0.5	9.7	14.1	6.4	1.5	0.4	0.0	0.1	33.9
19.0 - 24.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	4.9	6.5	2.3	0.5	0.0	0.0	0.1	14.7
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.7	2.7	0.8	0.0	0.0	0.0	0.0	7.3
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.5	0.1	0.0	0.0	0.0	0.0	1.6
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	2.7	2.7	3.8	2.6	0.9	0.4	0.3	0.6	1.8	23.3	33.7	19.6	3.8	1.2	0.6	2.1	
AVG. SPEED	8.1	5.7	7.0	8.7	4.9	3.6	3.8	3.7	11.2	18.4	16.2	13.8	13.6	10.5	6.8	8.3	

Calm Hours = 0.0% Total Hours With Both Speed and Direction = 2046 Average Wind Speed = 14.5 (MPH)

Resultant Windspeed = 11.6(MPH) Resultant Wind Direction = 224.9Deg Wind Persistance = 80.3 %

BISON ENGINEERING INC
HELENA, MONTANA

Envircon Livingston, Montana 1991

*** *WIND FREQUENCY SUMMARY* ***

DIR---> / SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0 - 4.0	1.1	1.8	1.4	1.2	0.9	0.6	0.4	0.5	0.9	1.4	1.1	0.7	0.5	0.4	0.5	0.9	14.1
4.0 - 7.5	1.0	1.6	2.1	1.1	0.4	0.4	0.1	0.2	0.5	1.4	2.1	1.4	0.8	0.5	0.4	0.6	14.7
7.5 - 12.1	0.9	0.9	1.4	2.1	0.8	0.2	0.0	0.1	0.3	2.7	6.6	7.9	2.6	0.6	0.4	0.6	28.0
12.1 - 19.0	0.4	0.1	0.7	2.5	0.6	0.0	0.0	0.0	0.3	5.5	8.6	5.6	4.2	0.6	0.2	0.3	29.3
19.0 - 24.7	0.0	0.0	0.1	0.8	0.2	0.0	0.0	0.0	0.1	2.8	3.6	1.3	0.7	0.0	0.0	0.0	9.6
24.7 - 30.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	1.7	1.3	0.4	0.1	0.0	0.0	0.0	3.7
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.6
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	3.4	4.4	5.6	7.9	3.0	1.2	0.6	0.8	2.0	15.6	23.5	17.4	8.8	2.2	1.4	2.3	
AVG. SPEED	6.9	5.5	7.7	11.8	9.2	4.9	3.9	4.0	7.2	15.5	14.3	12.6	13.1	9.3	6.8	7.0	

Calm Hours = 0.0% Total Hours With Both Speed and Direction = 7521 Average Wind Speed = 11.9 (MPH)

Resultant Windspeed = 6.7(MPH) Resultant Wind Direction = 230.60eg Wind Persistance = 56.1 %

APPENDIX B

QUALITY CONTROL CALIBRATIONS

ENVIROCON INC.
Livingston, Montana

PM10 Calibrations - Wedding & Assoc.

Calibrated by : Dan McCaffery
Location : Livingston BN Site Upwind
Sampler # : 0240901115U
Date : 10/10/91

Calibration Orifice #S48-ECON: Q [m3/min] =.4998 [(dP)^.50378]
Last Certified : 6/5/91

LOOK-UP:

Sampler Manometer = 22.7 inches water = delta
Barometric Press. = 25.32 inches mercury = P0
Temperature = 25 degrees celcius
= 298.2 degrees kelvin
P1/P0 = (P0 - [delta/13.6]) / P0
= 0.934

Q (look-up) [acfm] = {[T[k]/248]^0.5} *
{[(P1/P0) * 84.5238] - 42.329}
= 40.16 [acfm] l-u

Q (look-up) [scfm] = acfm * (P0*298) / (29.92*T[k])
= 33.96 [scfm] l-u

REFERENCE TRANSFER ORIFICE STANDARD:

Orifice Manometer = 3.9 = dP
Qr [m3/min]r = .4998 [(dP)^.50378]
= 0.992 [cmm]r

Qr [cfm]r = Qr [cmm]r * 35.314
= 35.04 [cfm]r

Qr [scfm] = Qr [cfm]r *
{(P0*298)/(29.92*T[k])}^0.5
= 32.22 [scfm]

Qr [acfm] = Qr [scfm] *
{(T[k]*29.92)/(298*P0)}
= 38.10 [acfm]

Q [scfm] % Difference = {(Q [scfm]lu - Qr [scfm]) /
Qr [scfm]} * 100
= 5.4 %

ENVIROCON INC.
Livingston, Montana

PM10 Calibrations - Wedding & Assoc.

Calibrated by : Dan McCaffery
Location : Livingston BN Site Downwind (Met)
Sampler # : 0240901114U
Date : 10/10/91

Calibration Orifice #S48-ECON: Q [m3/min] = .4998 [(dP)^.50378]
Last certified : 6/5/91

LOOK-UP:

Sampler Manometer = 23.85 inches water = delta
Barometric Press. = 25.42 inches mercury = P0
Temperature = 23.3 degrees celcius
= 296.5 degrees kelvin
P1/P0 = (P0 - [delta/13.6]) / P0
= 0.931

Q (look-up) [acfm] = {[T[k]/248]^0.5} *
{[(P1/P0) * 84.5238] - 42.329}
= 39.60 [acfm] l-u

Q (look-up) [scfm] = acfm * (P0*298) / (29.92*T[k])
= 33.84 [scfm] l-u

REFERENCE TRANSFER ORIFICE STANDARD:

Orifice Manometer = 3.9 = dP
Qr [m3/min]r = .4998 [(dP)^.50378]
= 0.992 [cmm]r

Qr [cfm]r = Qr [cmm]r * 35.314
= 35.04 [cfm]r

Qr [scfm] = Qr [cfm]r *
{(P0*298)/(29.92*T[k])}^0.5
= 32.39 [scfm]

Qr [acfm] = Qr [scfm] *
{(T[k]*29.92)/(298*P0)}
= 37.93 [acfm]

Q [scfm] % Difference = {(Q [scfm]lu - Qr [scfm]) /
Qr [scfm]} * 100
= 4.5 %